POWER

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ELY C. HUTCHINSON, *Editor*

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TECHNOCRACY

● SCARCELY ANYONE with the facilities of the press at his disposal has failed to say something or another about Technocracy. There is a good reason for this. Probably no other word has captured the imagination of more people. And probably no subject of recent years has so effectively resisted the understanding of those who earnestly seek its kernel of usefulness amid the maze of verbiage. Indeed it would be interesting to plot a curve of verbal energy consumption correlated with column inches of space consumed, against the factor of intelligent understanding.

● YEARS AGO, prior to 1915 in fact, William Henry Smyth, an able engineer and writer, concluded a manuscript which dealt with a plan for industrial control and in which he used the word "Technocracy." Due largely to the stress of the World War, this manuscript was not published until 1926, in a book entitled "Irascible Strong." Those who are interested are referred to page 284, where, according to all available information, "Technocracy" was first written.

● THE WORD first appeared in print in a series of three articles, written in 1919 and published in the magazine, "Industrial Management." Mr. Smyth there declared that during the period of war the United States developed a new form in government, for which there had been no precedent in human experience. He discussed what he terms a rationalized industrial democracy and states, "For this unique experiment . . . I have coined the word 'Technocracy'."

● THE AUTHOR, who is very much alive at present in Berkeley, Calif., personally decries the appropriation of the word, which he states came to him as a combination of technology and democracy, to other purposes.

● WHEN FIRST the Technocracy of Howard Scott came to public notice, which was about August of last year, it is notable that although known as an engineer, Mr. Scott chose the newspapers and not the professional publications for the presentation of his ideas. The danger of printing his incomplete findings for the consumption of the layman, without having passed them through the analytical process normally accorded to engineering studies, has been apparent from the first. Public reactions, which have since taken place, were anticipated and pointed out to their authors from the start. Unfortunately, these warnings were of no avail.

● A GREAT MANY PEOPLE took the subject very seriously and on all sides Mr. Scott has been pressed for a solution, that might be constructively applied to the dilemma he has voiced. People were entirely right in expecting an answer, for engineering is a constructive process and it has always been that old structures or old ideas shall give way only to new and better ones. Mr. Scott's only response, so far, has been a maze of high sounding words, from which has emerged his statement that, "Technocracy proposes no solution, it merely poses the problem raised by the technological introduction of energy factors in a modern social system." Thus one is left to his own determination of what it is all about, according to his lights.

● IN THE MIDST of a world condition, in which everyone from the humblest to the mightiest is hungering for a solution of the problems brought about by the depression, Technocracy has received an amount of attention which would have been accorded it at no other time. Fortunately, the spread of fire, fear and consternation, with which it was first met, has been stopped by the common sense of the people and their sense of humor. Gradually Technocracy will take its rightful place in the minds of the thinkers, and when it does, it is expected that there will remain two useful results from the conflagration.

● FIRST, it will have served a real purpose in the stimulation of minds bent upon finding what usefulness there may be in the idea and of which the author himself tells not.

● SECOND is the more immediately practical conclusion that the day will be saved, not by Technocracy but by the time-tested truth that prosperity still must be the reward of individual work and thrift.

EDITORIALS

BEER

Power takes no editorial stand on Prohibition. As a social and political question entirely outside of the power field its merits or demerits are to speak plainly, "none of our business."

But it is proper to face the technical implications of the imminent legalization of beer. The early starting up of many old breweries will raise innumerable questions which power engineers must answer. Electricity, process steam and refrigeration will be demanded at once and in huge quantities. Yet, at the best, equipment on hand to supply these services dates back to 1917; much of it is more than a quarter century old. Most of it can be made to *run* by extensive overhauling, but at what ultimate cost?

To produce 100,000 barrels of beer with this old equipment may easily require 3,000 tons of coal. So great have been the improvements in power units and hookups, so great the advance in by-product power generation, steam pressures and refrigerating practice, that this coal consumption can be cut in half by modernization. In some cases fuel savings as high as 60 per cent are obtainable.

The brewer must compete for profits in an open field where the price of his product will be fixed by factors beyond his control. His profits will depend largely upon his ability to keep down costs, and this is entirely an individual matter in which an understanding of his power problem is a vital factor.

Power has met the immediate need for basic information by securing the leading article in this issue. It is addressed directly to brewing engineers and executives. Its authors speak with the assurance that comes from first-hand knowledge. Its approach is entirely practical.

Share the Work

At its best, the "Share the Work" movement is not a cure all. While it is helping, it must be realized that it cannot be applied universally. Many kinds of work cannot be successfully shifted from one person to another.

There is no reason, however, why the principle cannot be adopted in other ways. As an instance, giving aid to the unemployed is certainly the equivalent of "sharing the work" of the giver.

But, at bottom, this is not giving men employment—and that is what they want. That is what the Robertson Committee is working for.

Industries which place orders for needed and profitable power plant rehabilitation are making jobs for others. And that is the sort of work sharing which helps the most.

Orders profit the purchaser in reduced power cost and give men jobs and their self respect. Industrial executives should be told that there is no more practical or fundamental "Share the Work" plan than this.

Heat Plus Power

Engineers are now fully aware of the fact that the supply of heat and power to a factory is a single problem, not two. Many industrial owners and executives, on the other hand, still imagine that heat is one problem and power another, and that the two can be considered separately. Millions of dollars are being lost to American industries through failure of top executives to get this straight. And the time is here when preventable waste can no longer be tolerated.

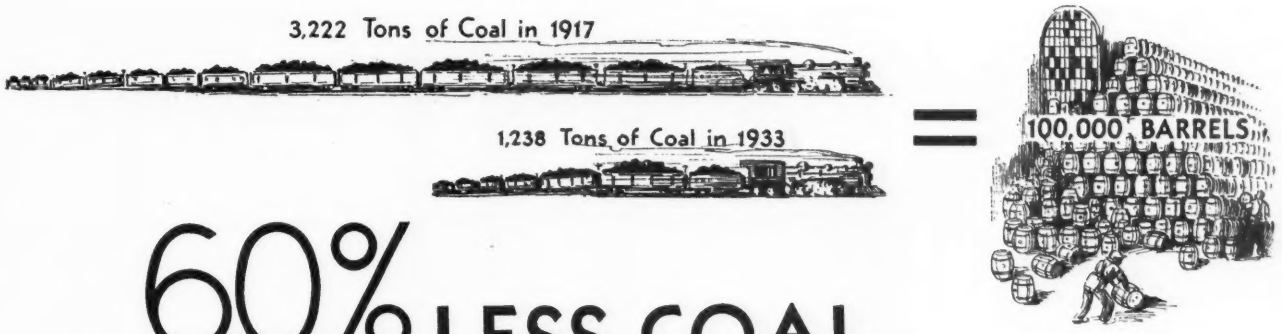
The article by M. K. Bryan (page 67) should help this situation. Every power engineer will want to read it to check his own understanding of the heat-power relation. He may then find it advisable to bring the article to the attention of some owner or executive whose misunderstanding of the heat-power problem is a barrier to potential savings.

This article deals with fundamental principles. Two more, to appear shortly, will get down to the brass tacks of specific installations, showing for each how steam pressure and temperature, exhaust pressure and hook-up have been adjusted for dollar economy.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of By-product Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



60% LESS COAL FOR 1933 BEER

By FRED OPHULS and A. B. STICKNEY

President, Fred Ophuls & Associates, Inc. — *Engineer,*

WHEN beer is legalized, brewery profits will depend largely upon the differential between production costs and a fixed sales price. Fuel costs—a major item—can be cut from 50 to 60 per cent by modernization of the equipment and hook-up supplying steam, electricity and refrigeration.

Among the questions confronting the brewer about to resume operations not the least important are these four:

1—Can our present power plant be put in shape to enable us to produce beer?

2—Will rehabilitation of this old equipment be economical, or can we get a large return on money spent for new equipment in the power plant?

3—How can we take advantage of the vast technical developments in the power field since Prohibition?

4—Even if a much better installation can be made, will making it delay the start of operations too long?

While these, and the many other questions which they suggest, cannot be answered without studying each brewery individually, some general statements can be made which throw considerable light on the problem.

Brewery Power Services

To review briefly the place of the power plant in the brewery: steam at various pressures, power, hot and cold water and refrigeration are necessary at various points in the brewing process, and these are furnished by the power department under the chief engineer. Steam at 90- to 150-lb. pressure is needed for driving machinery, and for drying spent grains in breweries where this is necessary and where old-style dryers are used. Steam at 20- to 50-lb. is needed for cooking and preparatory heating processes and for pasteurizing and soaking. Exhaust steam at 3 to 5 lb. is needed for water heating and for grain drying where low-pressure dryers are used. Power is needed for refrigeration, conveying, mixing of materials, pumping and for the operation of bottling and other machinery. Hot water is needed for brewing, boiler feed, and also for washing and cleaning. Cold water is needed for cooling wort, for washing and cleaning and for condensing ammonia and steam.

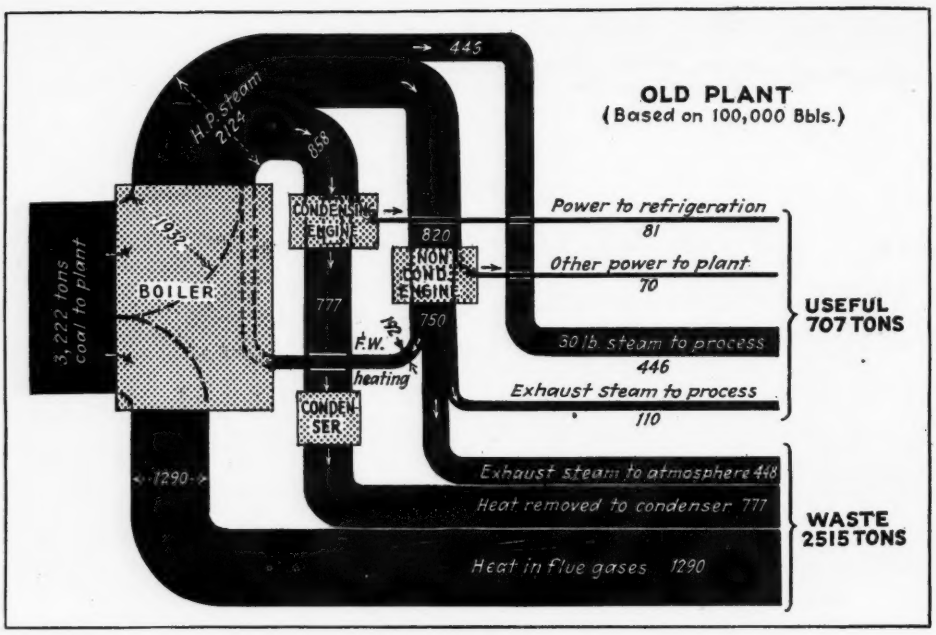
The Pre-Prohibition Brewery Plant

In the pre-prohibition brewery, built, say, between 1910 and 1915, these services generally were provided about as follows: Steam at 100- to 150-lb. pressure was made in boilers by burning coal or oil. The boilers generated 4 to 5 lb. of steam per hour per sq.ft. of heating surface, and their average efficiency was about 60 to 65 per cent. The coal was burned on grates 2½ to 4 ft. below the boilers. Live steam direct from the boilers was reduced for uses at high and medium pressures. Steam needed at 3 to 5 lb. was expanded through reciprocating engines, which drove generators, slow-speed ammonia compressors, pumps and other machinery. These engines generally required from 22 to 35 lb. steam per i.hp.-hr. Any additional power in excess of that available from the low-pressure steam was generated by expanding additional steam through condensing engines, requiring 15 to 18 lb. per i.hp.-hr.

In many cases of starting up a brewery which has been shut down a long time, the major equipment has been preserved well enough to be put in shape to operate again. However, this should be checked very carefully, as corrosion and breakage have undoubtedly taken their toll and extensive reconditioning is essential. The major items, such as the insurable boiler pressure, the condition of boiler settings, baffles, flues and stacks, fuel handling, feeding and burning equipment, pump and engine cylinders, bearings and valves, tightness and strength of pipes, pipe joints and valves, insulation, water system and electrical equipment be carefully inspected, checked, cleaned and the necessary repairs made. Moreover, innumerable small but nevertheless important and essential items must be taken care of.

To cite only a few of these: gages, controls and safety devices must be checked and calibrated, gage lines must

be cleaned and made tight, lubricating lines and devices must be cleaned and reconditioned, wells must be pumped for a period to remove foreign matter, filtering material must be sifted, cleaned and renewed if necessary, gaskets and packing must be renewed, pump equalizing lines cleaned, condenser vent and safety lines checked, etc., etc. Such a list could be continued indefinitely, but the point to be made is that competent hands must be given adequate time to recondition the equipment in all of its details, before safe operation can be undertaken.



BEFORE MODERNIZATION

Where the coal goes in a 100,000-bbl. brewery, and how it can be reduced from 3,222 tons to 1,230 tons per year.

However, even if the machinery of the old brewery is in perfect condition, such great progress has been made in power-plant engineering in the last 15 years that the old machinery is completely obsolete, and in many cases complete new installations, embodying the best of present-day practice, will pay for themselves in a very short time.

A new brewery power plant has three outstanding differences from an old one, and innumerable smaller ones. The first of the three is the boiler, as to both pressure and rating. Boiler pressures have gradually increased during the last decade, until today pressures up to 450 lb. per sq.in. are considered sound and conservative for industrial plants. This means an enormous cut in the brewery fuel bill, since enough additional power is available from the steam used in process to reduce the load greatly on or entirely obviate the necessity of condensing engines. In addition to the saving in fuel because of decreasing the steam requirements, the water supply for steam condensing is greatly reduced or eliminated.

Hand in hand with increasing pressures have come increased boiler ratings, 10–12 lb. of steam evaporated per sq.ft. of heating surface per hour being not uncommon with 450-lb. boilers. Thus an old 2,500-sq.ft.[1] boiler working at 150-lb. pressure may generate 10,000 lb. of steam per hour, while a modern 2,500-sq.ft. boiler at 450-lb. may generate 30,000 lb. per hour. Therefore, fewer boilers are necessary.

The second outstanding difference is in the combustion system. Much has been learned about the economical burning of coal in the last 15 years, with the result that industrial boiler efficiencies above 80 per cent are readily obtainable, and cheaper grades of fuel can be used. This means that one-quarter of the fuel is saved as compared with the old 60 per cent efficient plant.

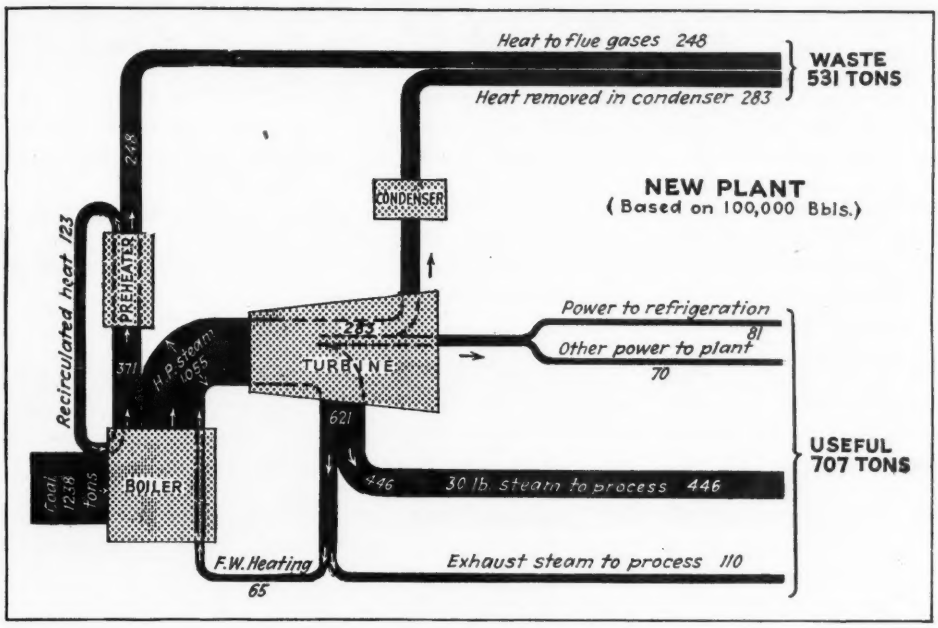
This improvement is the result of a number of changes. First, the furnace volume has been greatly increased. Instead of $2\frac{1}{2}$ to 4 ft. from grate to boiler, 10 to 20 ft. is common. Second, mechanical stokers have been greatly improved, and an alternative method of firing powdered coal blown in by a stream of air has been developed. Which method should be used depends on a variety of circumstances, and should receive careful study, as should also oil firing. Third, water walls have been developed, which both cool the furnace and increase the steaming rate of the boiler. Fourth, the air for combustion is preheated several hundred degrees by absorbing heat from the flue gases going from the boiler to the stack. The heat recovered is a direct gain. Fifth, careful, accurate and continuous control of combustion conditions, based on exact knowledge, is readily obtainable.

Third, the prime mover will probably be a bleeder-type turbine, driving a high-speed electric generator. This has several advantages over the old reciprocating engines. First, the steam supplied at any pressure is uncontaminated with oil, and can therefore be used for direct contact heating. Second, the machine is very flexible, and will automatically supply the fluctuating amounts of steam required at various pressures while maintaining these pressures constant. Third, this equipment is very reliable and requires a minimum of attention.

Auxiliary equipment and operating aids have also been developed and improved. These include pumps, heaters, controls, instruments, valves and pipe joints, water treatment, and many others. To get the maximum benefit from the modern plant, it is essential that all the individual items, both major and minor, be integrated both to make a unified whole and properly to meet the brewery demands. A thorough analysis of the heat balance and its relation to other conditions is necessary to reveal the idiosyncracies of each individual plant and to serve as a basis for proportioning the equipment. The machine age has not yet found a substitute for brains, and the economy of a given plant will depend on the intelligence, experience, thoroughness and integrity of the designer.

Let us now see how the performance of an old brewery power plant and a new one compare. Obviously, it is impossible to set up any exact figures as typical, because

[1]Under the old system of rating 10 sq.ft. of surface as 1 "Boiler Horsepower", this would be a 250-hp. boiler.



AFTER MODERNIZATION

All figures are prorated from computations made for a brewery turning out 164,420 bbl. annually

of the variations of process, layout, water supply, season, etc., which lead to variations in the magnitudes and relations of power and steam requirements. For example, a brewery which can dispose of its spent grains without drying requires less steam per barrel of beer brewed than a brewery which must dry them. A brewery with an adequate supply of cold water requires less refrigeration, less power per ton of refrigeration, and more steam for water heating than one which has cooling towers or a spray pond.

Many other variations suggest themselves. However, for purposes of illustration, let us consider a certain brewery in the tropics which produces about 165,000 barrels of beer annually, of which 100 per cent is bottled. An ice plant is operated in conjunction with the brewery, but in the following figures this is omitted, and the figures adjusted accordingly. Steam is produced at 125 lb. in oil-fired boilers, and the steam needed at 30 lb., the highest process pressure, is supplied through reducing valves. Compressors are driven by condensing engines, and other power requirements are supplied by non-condensing engines, which supply the 5 lb. steam needed. Condensing water is taken from a river and other water requirements from wells. In this brewery, 435 barrels are produced per brew. Let us assume that beer is made on 300 working days in 378 brews, there being 2 brews per day on 78 days and 1 brew per day on 222 days, or a total of 164,430 barrels per year.

The annual power-service requirements in this plant are as follows:

30-lb. steam for process, lb.	19,950,000
5-lb. steam for process (exclusive of feedwater heating), lb.	5,040,000
Refrigeration, ton days	27,800
Other power, kw.-hr.	874,000

In order to produce these quantities with the existing old-style plant, it is necessary to produce 80,830,000 lb. steam, of which 24,990,000 lb. is used in process as shown, 9,720,000 lb. is used for feed-water heating, 24,360,000 lb. is condensed in producing the refrigeration, and 21,760,000 lb. is the excess over 5-lb. steam requirements for process and feed-water heating exhausted to the atmosphere in the production of electric power. With a boiler efficiency of 60 per cent, and assuming, for illustrative purposes, that coal having a heating value of 13,000 B.t.u. per lb. is used in place of oil, the annual coal requirement would be 5,300 tons.

The new-style plant assumed for purposes of comparison has a sufficient cold-water storage to equalize the wort cooling load and a sufficient hot-water storage to give a balanced load condition. Its 450-lb. pressure boilers supply superheated steam at 600 deg. to a condensing turbine having a single bleed point at 30 lb., and 5-lb. steam being supplied through reducing valves from the 30-lb. mains. The ammonia compressors are electrically driven.

A very different picture is presented with this assumed set-up. It is now necessary to generate only 37,800,000 lb. of steam, of which 24,990,000 are used in process as before, 2,750,000 are used for feed-water heating, and 10,060,000 are condensed. At a boiler efficiency of 80 per cent, this requires 2,035 tons of coal, or only 38.4 per cent as much as with the old plant. In addition to this enormous fuel saving, a much smaller plant is required, and an operating force of only 2 men per shift is necessary.

The charts on this and the previous page show graphically the flow of energy through this plant from coal pile to beer manufacture, both before and after modernization. For ease of comparison with other plants, all the figures have been prorated down to a plant output of 100,000 bbl. of beer a year. All energy figures are given in tons of coal per year.

In still more simple, and more dramatic, form the coal saving possible is pictured at the head of this article.

Actual Examples of Dollars Saved

As practical examples of what actually has been done in brewery power plants, two examples will suffice. During 1929-30, in one of the largest breweries in this country, three new 10,760-sq.ft. boilers, at 450 lb. were substituted for 25 old 150-lb. boilers totalling 101,240 sq.ft. Two of the new boilers can carry more load than the entire old plant. Two 3,000-kw. bleeder turbines, operating between 450 lb., 150 lb. and 5 lb., supply current previously generated by oil engines or purchased, and exhaust into the old 150-lb. and 5-lb. mains. The old reciprocating engines, driving generators and ammonia compressors, are still in use. The new plant can use a cheaper grade of fuel than the old. The consumption has been cut about 15 per cent, or 15,000 tons per year, and at the same time over 5,000,000 kw-hr. formerly purchased or generated by oil engines are now generated as by-product power. In addition, a much

smaller operating force is required than was needed in the old plant.

As an example of how special conditions may modify the requirements, and also of how rapid the progress of power-plant practice has been, let us consider a Cuban brewery, in which a modern power plant was substituted for the old one during 1925-6, with a resulting fuel saving sufficient to run a new 300-ton ice plant, built at the same time, without increasing the fuel consumption. At that time boiler pressures had not attained their present levels, and since considerable power in addition to the brewery requirements was needed, and an entire river was available for condensing water, 225-lb. boilers, oil fired, and condensing turbines, were adopted. The great improvement in economy demonstrates the development of combustion methods and prime movers, taking only partial advantage of the by-product power possibilities now available.

In view of the above, there can be little question that post-Prohibition developments in the power field have much to offer the brewery in providing more economical operation. However, the brewery problem also has a time factor involved. When beer is legalized, the question becomes, *"How soon* can we make beer?" and it is not possible to wait while a new power plant is being built, no matter how well it may pay after completion.

Rebuilding Without Stopping Production

If the old plant can be operated at all, the problem can be solved by operating the old equipment while the new is being installed. If the new plant can be built in a new location, adjacent to or near the existing power plant, the solution is, of course, simple, for the new plant can be erected, ready to operate, without interfering with the existing system, and pipes, cables, etc., brought nearly to the new points of connection. The new system can then be cut in during a very short shut down, say over a week-end, and operations resumed using the new plant.

When, however, it is necessary to rebuild within the space already occupied, the solution is more complicated, although almost always feasible. The saving feature is that the new equipment is generally much less bulky than the old, and consequently if one small replacement item can be installed in unoccupied space, and the service cut over to it, the removal of the older and bulkier apparatus makes way for a larger replacement. This process is cumulative, so that eventually enough space is gained to enable the major equipment to be replaced.

While this takes very careful planning, is time-consuming, may be somewhat more costly than building in a new location, and does not always permit the most ideal layout, it has been done innumerable times where conditions require it, and if properly done gives satisfactory results. Generally, study will reveal that with a few temporary connections and the removal of not absolutely essential equipment, and perhaps by placing some of the new equipment in a temporary location, the transformation can be made in two or three steps.

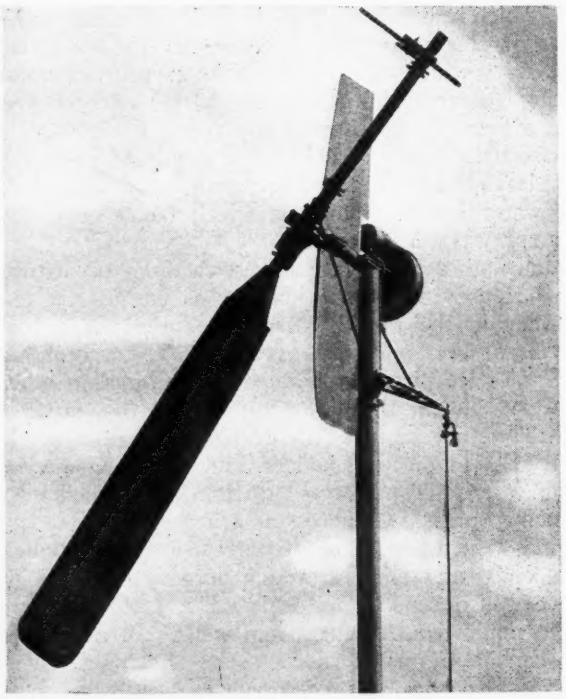
Thus, for example, in the large brewery discussed above[3] where 25 old boilers were replaced by three new ones, it was found that four of the old boilers could be dispensed with, as well as much of the feed-water heating equipment. In the space so vacated, two of the new boilers were installed, and with one of these operating and the other as a spare, ten more old boilers were removed, making room for the third new one, space for a future boiler, the turbine room and the switchboard. The last eleven old boilers were not removed until after the new plant was completed, and the space they occupied was eventually a net gain. In this case the saving from reusing the building greatly overbalanced the more costly method of construction.

Even if immediate rebuilding is not contemplated, it is well to study the eventual layout of a new plant, so that additions and changes will fit into the new set-up when it is finally undertaken.

The Road to Profits

In conclusion, the power plant of a brewery can be improved so far over the best available in the pre-prohibition era that no brewer can afford not to investigate the economies possible due to the technical advances in this field. The brewer who fails to study this phase of his business is imposing a tremendous handicap on himself in the keen competition which is bound to develop. However, the design of a power plant for best results is so much a specialty that the brewer will do well, in studying this phase of his plant, to entrust it to thoroughly competent and experienced hands, conversant with the most recent practice.

[3] See *Power*, June 17, 1930, "New Anheuser-Busch Plant."



SINGLE-VANE WIND TURBINE

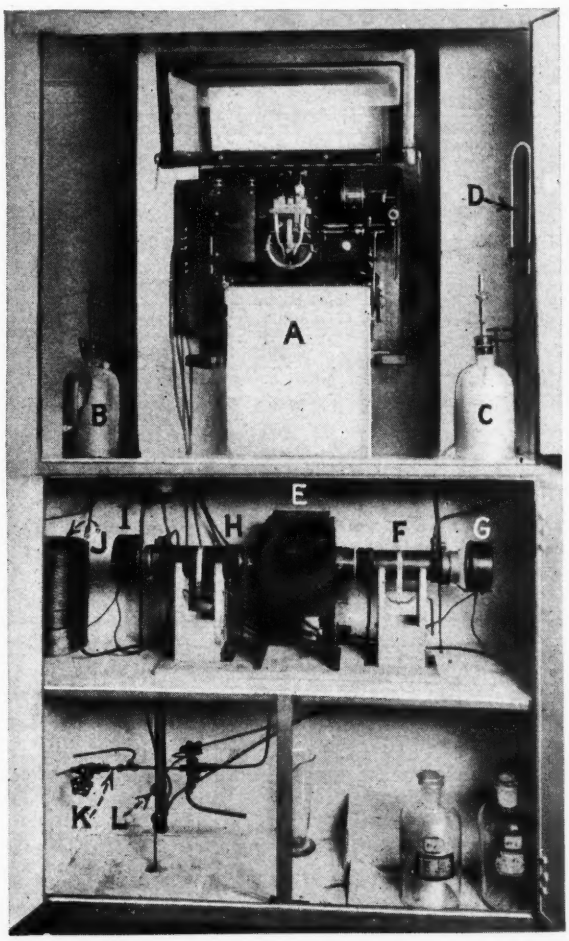
● LOW-COST electrical energy for advertising signs and similar low loads at points of sustained air circulation is promised by this wind turbine, using stainless-steel hollow air-foil vane fabricated by the shot-welding process. Illustrated is a 1-kw. unit with the generator mounted on the mill shaft and operating through a 9-1 step-up gear. Speed of the unit is practically constant at 120 r.p.m. for all wind velocities above 15 m.p.h., attained by automatic feathering of the single, balanced vane. Developed by Robert W. Weeks of the Wind Turbine Co., West Chester, Pa.

DISSOLVED-OXYGEN RECORDER

AT SEAL BEACH

By CLARK PETTINGILL and E. J. BARLOW

Seal Beach Station
Los Angeles Gas and Electric Corporation



TO FULFILL the need for a continuous record of oxygen concentration in feedwater, a dissolved oxygen recorder has been developed and placed in operation at the Seal Beach Station of the Los Angeles Gas and Electric Corporation. Laboratory methods of determining oxygen concentration, while reliable, are obviously not practical for obtaining a continuous record.

Employing the principle of radiation absorption, the apparatus consists of a liquid cell, a reagent feeding system, a point source of radiation, radiation sensitive devices and a potentiometer-recorder. The light-sensitive devices may be either theromopiles or photo-electric cells. The method of compensation used makes the instrument independent of any change in radiation source or water turbidity. Reagents are inexpensive and easily obtained, and the amount of water taken from the feed-water system is small.

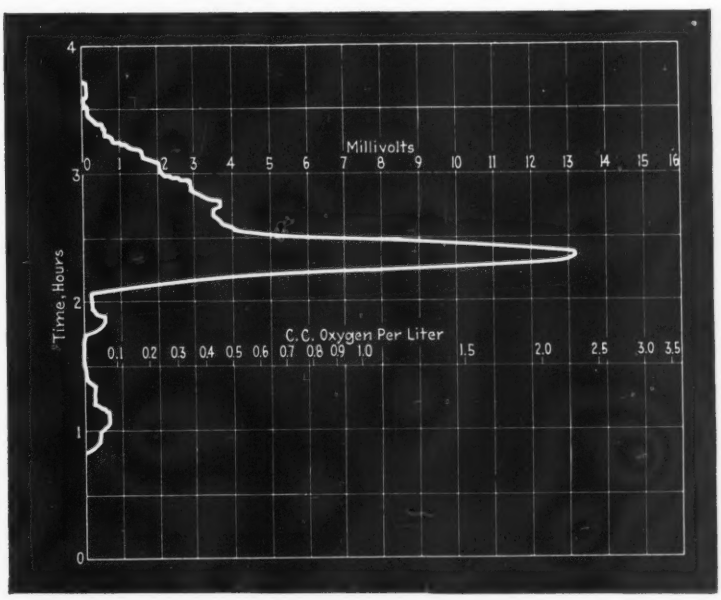
Records obtained have initiated a number of changes in methods of handling. These have resulted in practically oxygen-free feed water except when starting up. One example is the high concentration of oxygen in feed water recorded when one of the main units is started and before normal vacuum is established in the condenser, the concentration being due to air-saturated water which accumulates in the hot well. By rearranging the piping system from the make-up storage so that water could be fed into the top of the turbine condensers and be deaerated, oxygen concentration has been reduced to a negligible amount.

Sensitive to minute quantities of oxygen (.01 c.c. per liter) the instrument has an accuracy beyond practical needs. Due to the shape of the calibration curve, the scale is open at the lower end and crowded toward the top, which is desirable as it enables low concentration to be read with ease and precision. The first hundredth of a.c.c. per liter is about one-sixteenth inch on the chart.

Records obtained from the apparatus have given much valuable and somewhat surprising information. Its use has enabled the operating staff of the station to make changes which have improved performance, and the recorder now is considered indispensable.

RECORDER OPERATION

A single light source *E* projects both left and right. Left beam passes through cell *H* containing water to which no reagent has been added. Light not absorbed falls on thermopile *I*, producing there a potential. Similarly right beam traverses cell *F* containing water to which reagent has been added. Light not absorbed falls on thermopile *G*. Potentiometer *A* measures difference of potential between *I* and *G*, which, in turn, increases with the amount of dissolved oxygen in the water. *B* and *C* are reagent bottles, *D* a flow indicator, *J* coils of copper tubing restricting flow of water-displacing reagents.



Section of recorder chart, redrawn. Sharp peak of 2.3 c.c. per liter occurred at starting of main unit.

Composition of boiler water drawn for analysis is influenced by point and time of sampling and method of feeding. Relative importance of these factors is shown by tests here reported

GOOD BOILER WATER SAMPLES
DEPEND ON POINT AND TIME

THE character of make-up boiler feed water at many plants is such that a close check must be kept of the total solids and sulphate-carbonate or phosphate-carbonate ratios actually existing in the boiler. For this purpose samples of the boiler water must be taken regularly and sent to a chemist for analysis. From the reported analysis the feed water treatment may be controlled, and the periods and amounts of blowdown determined. Obviously, if the sample analyzed is not representative of the water in the boiler, improper feed treatment or incorrect blowdown may result. In some cases, such as those where embrittlement is involved, it is desirable that the samples represent the least favorable water conditions in the boiler.

It is common practice to take samples of boiler water from either the water-column blowdown connection, boiler blowdown connection, or continuous blowdown line, but how closely samples from these points represent conditions in the boiler is generally unknown. Other factors that may affect sampling are: the method of admitting feed water to the boiler, and the time of sampling when the slug method of treatment is employed.

With these factors in mind, an investigation was made on a Stirling type boiler with 14,460 sq.ft. of heating surface, fired with pulverized coal, operating at 175 lb. pressure and 250 per cent rating.

The water fed to this boiler was 95 per cent make up from Lake Erie and 5 per cent condensate. Feed water treatment on the date of testing was 20 p.p.m. of 80 per cent sodium aluminate, and 33 p.p.m. of soda ash, slug fed every eight hours. Runs were made 2½, 4 and 5½ hours, respectively, after the start of the morning slugging. A typical analysis of the feed water treated is

	P.p.m.
Bi-Carbonate Hardness (as $Ca\ CO_3$)	87
Permanent Hardness (as $Ca\ CO_3$)	28
Calcium	34
Magnesium	10
SO_4	24
SiO_2	2
Cl	14
Free CO_2	3
Dissolved Solids	155
pH	7.4

In making the tests samples were taken at seven different points in the boiler, in the following order: Water-column blowdown lines, east and west, mud-drum blowdown lines, east and west, water-screen blowdown lines, east and west, and continuous blowdown connection in the middle drum at the east end.

The results of the tests made when feeding water equally to both ends of the boiler, when feeding only to the west side, and when feeding only to the east side, are shown by the curves in Figs. 1 and 2. Feed water enters at each end of a conventional feed trough, set level, through a perforated submerged line.

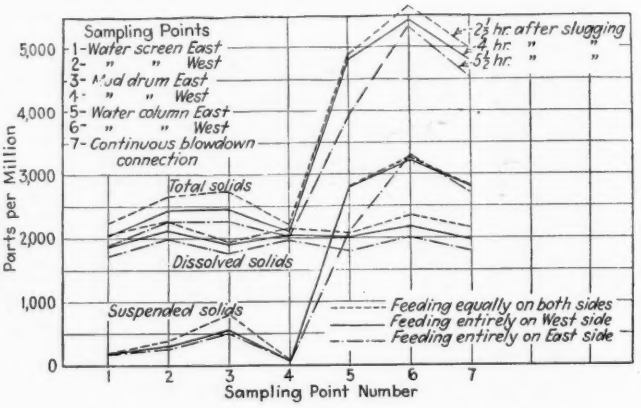


Fig. 1—Effect of point of sampling on dissolved, suspended and total solids with three different feed conditions

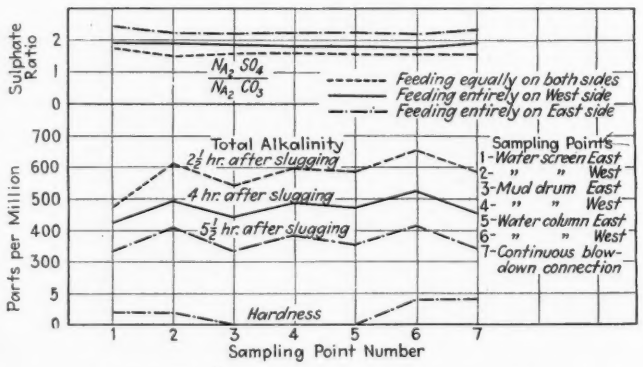


Fig. 2—Effect of point of sampling on sulphate ratio, total alkalinity and hardness for three feed conditions

From the results shown by these curves it is evident that the location of the continuous blowdown connection, and the elapsed time after slugging treatment of the feed water, have a far greater effect on the sample characteristics than has the point of admission, feed water distribution apparently being uniform.

For boilers internally treated with slug feeding of chemicals the time elapsed after slugging is an important factor in boiler water sampling, as shown in Fig. 2. If a boiler water is to be analyzed for embrittlement characteristics, the samples should be obtained soon after slugging, at which time the embrittlement ratio will come

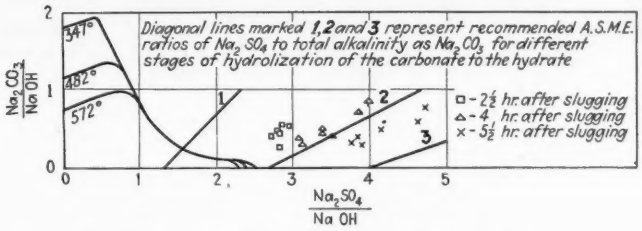

Diagonal lines marked 1,2 and 3 represent recommended A.S.M.E. ratios of Na_2SO_4 to total alkalinity as Na_2CO_3 for different stages of hydrolization of the carbonate to the hydrate
341°
482°
572°
□ - 2½ hr. after slugging
△ - 4 hr. after slugging
× - 5½ hr. after slugging
$\frac{Na_2CO_3}{NaOH}$
$\frac{Na_2SO_4}{NaOH}$

Fig. 3—Straub chart showing ratio of carbonate and sulphate to NaOH necessary to inhibit embrittlement

closest to the danger line when plotted on the Straub chart, Fig. 3.

The agreement is excellent between the samples from the east water column and the continuous blowdown connection. The west water column samples, however, show higher solids, while the samples from the main blowdown connection yielded results very low in suspended solids. The low showing of suspended solids in the mud-drum and water-screen samples is probably due to the method of obtaining the samples, rather than to the actual water conditions in the mud drum. In taking samples the blowdown valves on the mud drum and water screens were open for a few seconds to clear the lines, and were then closed, this to prevent too much water from being blown off. The sample was then taken from a stagnant zone where the suspended solids had settled to the bottom. A subsequent test, in which mud-drum samples were taken while the main blowdown valves were open, showed close agreement with the samples taken simultaneously from the continuous blowdown line.

It is of interest to note, however, that the samples taken from the points on the east side of the boiler are consistently lower in solids and alkalinity than the samples taken from corresponding points on the west side of the boiler. This is due to the fact that the continuous blowdown connection is on the east side of the boiler, and because of relatively slow cross-circulation, the effect of the continuous blowdown is greater on the east side.

For determinations of boiler water for hardness and alkalinity, the samples should be obtained when the greatest time after slugging has elapsed, or immediately before the next slugging period. At this time the effects of the treatment are at a minimum, and the alkalinity is at its lowest value with the hardness at its highest.

The boiler was run at 100,000 lb. of steam per hour throughout the test. The continuous blowdown line from the east end of the upper middle drum was open throughout the test, resulting in a blowdown of approximately 3½ per cent. The water level was maintained constant at 12 in. in the west gage glass. The total elapsed time between taking the first and last sample on each run was approximately 10 min.

It should be recognized that the results obtained from these tests apply to a specific boiler, and too general conclusions should not be drawn from them. It is evident, however, that the method of sampling, time of sampling and point of sampling may influence greatly the results obtained and the feed water treatment.

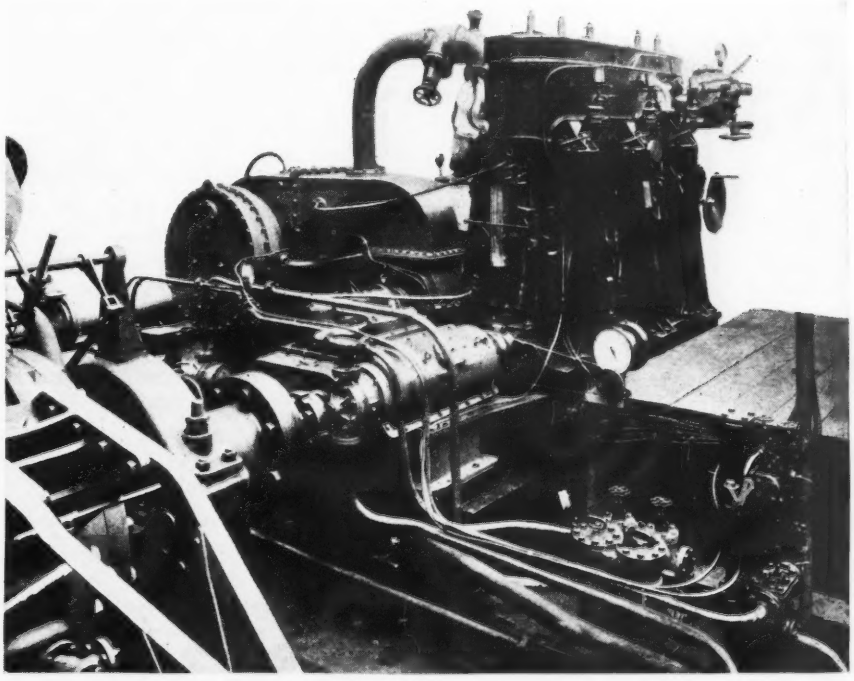
▼ ▼ ▼

ENGINE AND EXHAUST TURBINE IN ONE UNIT

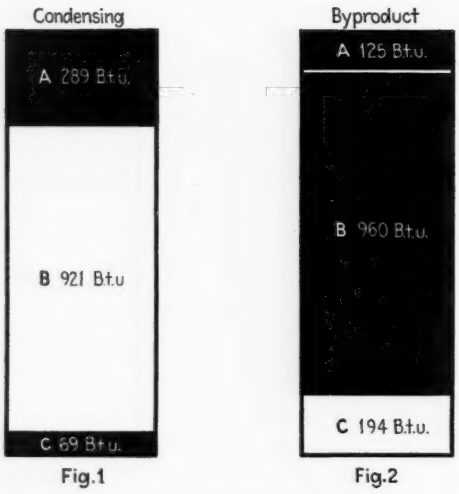
THIS triple-expansion engine combined with a low-pressure turbine in a single unit has been developed recently for marine service by the White Marine Engineering Company, Ltd., England. This engine and turbine unit on official trials, it is reported, showed a steam consumption of 9.44 lb. per b.hp. when supplied with steam at 222 lb. pressure, 586 deg. F. and exhausting to 0.92 in. Hg abs., developing 475 hp.

The engine follows generally accepted marine practice in its main frame and Stephenson valve gear mechanism. The 10-in. diam. high-pressure cylinder is provided with piston valves, and the 14- and 18-in. diameter intermediate- and low-pressure cylinders have slide valves. The engine operates at a design speed of 260 r.p.m. with a 13-in. stroke and drives the propeller at 112 r.p.m. At this speed the engine develops 310 i.hp.

With the propeller operating at 112 r.p.m. the turbine operates at 4,600 r.p.m., receives steam at about 34 lb. and develops 210 i.hp. A changeover valve is provided which allows the engine to exhaust direct to the condenser instead of to the turbine. This changeover operation is automatic when the engine is reversed. A maximum output of 650 i.h.p., it is said, can be obtained.



HEAT + POWER =



Comparison of use of the 1,279 B.t.u. in one pound of steam in condensing plant (Fig. 1) and industrial plant. Black areas represent heat usefully applied

The problem of steam pressures and temperatures in industrial plants is simply that of by-product power. This article, dealing with dollar-saving fundamentals, is directed to industrial executives, as well as power engineers

▼

GENERALLY, "by-product" power is the cheapest power available to the industrial plant because its production is incidental to furnishing heat for space warming and process work. Since the generation of by-product power dates from the early days of the steam engine, one might reasonably expect its application to have been refined and used wherever economic justification could be found. Yet refusal to acknowledge its possibilities is common.

The foundation of low cost is minimum waste. This article will explain, non-technically, how power may be made as a by-product of heat requirements, with less waste by the industrial plant than by other plants.

A significant distinction between the industrial power plant and a power plant whose single purpose is to make power is often overlooked. Both the pure power plant (or central station) and the industrial power plant are customarily referred to as "power plants." The industrial job is more than a power plant. Its primary purpose is to supply heat to the factory, and power supply by it then becomes an adjunct to the essential purpose; so that "heat plant" would be a better name. If its problems were regarded as heat engineering problems rather than as power problems, there would be less misunderstanding.

The working principle of steam plants can be simply stated: Heat stored in fuel is delivered to the plant. The fuel is burned, releasing the heat, which is transferred to water and steam. This water and steam carry the heat from the boiler plant to various points where it is unloaded and used as heat or is converted into power.

In a picture of heat handling it will be helpful to think of water and steam as vehicles carrying heat, to regard the boiler plant as a machine which unloads heat from fuel and reloads it into water and steam, and to think of engines, pumps, turbines, and process uses (such as dryers, digesters, water heaters and room radiators) as machines to unload heat from steam and water.

This analogy is applicable to all steam power plants. Their competitive positions are obviously influenced by the amount of heat wasted in completing the transfer from fuel to the ultimate uses.

Comparison of this transfer as accomplished in the pure power plant, and in the industrial plant making power as a by-product of process heat requirements, points to the possibility of lower power costs in the industrial plant.

The boiler plant can be a fairly efficient machine in transferring heat from fuel to steam, and the necessary waste there need not be more in the small plant than it is in the large one. In well-operated boiler plants this ranges between 15 and 30 per cent of the fuel, about 10 per cent being a practical necessity. Advancement of boiler-plant design and operating practice affords the small plant a commercial or dollar efficiency equal to that of the larger plant. In many cases, as a result of load factor, it may be even greater.

Handling heat from the fuel to the unloading machines can be accomplished with equally good economy by either the industrial plant system or the central station system. Beyond this point there is a considerable difference in the heat economy of these systems.

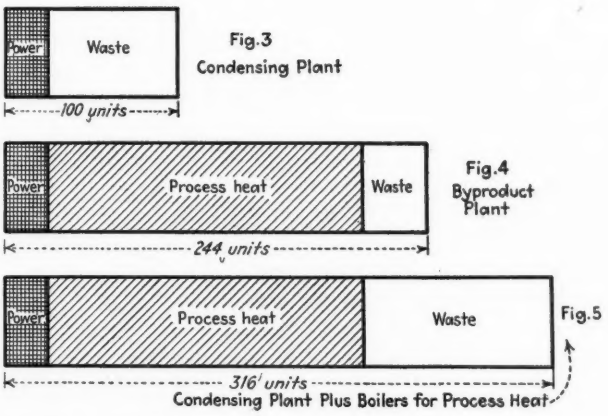
Heat is *unloaded* from the steam in the pure power plant to be converted into power, and in the industrial plant to be used principally as heat without conversion and secondarily for transformation into power.

The amount of available heat energy converted into power depends in all cases upon the expertness applied in designing and constructing the turbines or engine. The range in the efficiencies of commercial machines to convert heat into power is within such limits that the pure power plant is not afforded any great advantage over the industrial plant through the use of more efficient power generating equipment.

Steam rates are not necessarily an absolute measure of performance. A truer measure of performance for the industrial plant's use is the amount of heat recovered for all useful purposes combined. While the condensing machine uses less steam per unit of power output than the non-condensing machine, it does not necessarily follow that the useful application of heat is greater in the case of the machine with the lower steam rate. Such a machine unloads *more* heat from each pound of steam

DOLLARS SAVED

By M. K. BRYAN
Chas. T. Main, Inc., Engineers



Figs. 3, 4 and 5—Total fuel requirements compared for (Fig. 3) straight condensing plant, (Fig. 4) straight byproduct plant (Fig. 5) Condensing plant plus boilers to supply process load directly

handled, but in so doing it lessens, if not actually destroys, the utility of the heat not converted to work.

On the other hand, the conversion of a smaller amount of heat, as performed by the non-condensing turbine, leaves the remaining heat in a state in which it can be profitably used by industrial processes. In this fact lies the explanation for the difference of waste in the two systems.

Figs. 1 and 2 compare the two types of plants. Fig. 1 is drawn for a condensing turbine, with throttle steam at 400-lb. gage pressure and 110 deg. F. superheat, exhausting to a condenser vacuum of 28 in., and using 13 lb. of steam per kw.-hr. Fig. 2 represents a non-condensing turbine with throttle steam conditions of 150 lb. pressure and 150 deg. superheat, exhausting to process uses at 5 lb. pressure, and using 30 lb. of steam per kw.-hr.

The heat content of a pound of throttle steam (1,279 B.t.u.) is the same for each turbine and is represented by the entire area $A + B + C$. The heat in a pound of the exhaust, and available for use, is represented by $B + C$. The heat converted into power is the amount unloaded in passing through the turbine, and is the difference between that at the throttle and that at the exhaust. This is represented by the area A.

The condition of the exhaust from the condensing turbine is 28 in. of vacuum and 101 deg. F. temperature, while the steam from the non-condensing turbine is under 5 lb. pressure at 228 deg. temperature. Remembering that temperature difference is essential for heat transfer and that pressure difference is necessary for steam velocity, it is then obvious that the heat $B + C$ left in the steam is degraded more by the condensing turbine than by the non-condensing machine. Because of its low temperature and lack of pressure, the heat exhausted from the condensing machine is practically useless.

On the other hand, the pressure at the non-condensing turbine exhaust will move the steam to a point of use, and the higher temperature at which it carries the heat allows this to be unloaded and put to practical uses, such as heating water, drying paper or cloth, etc.

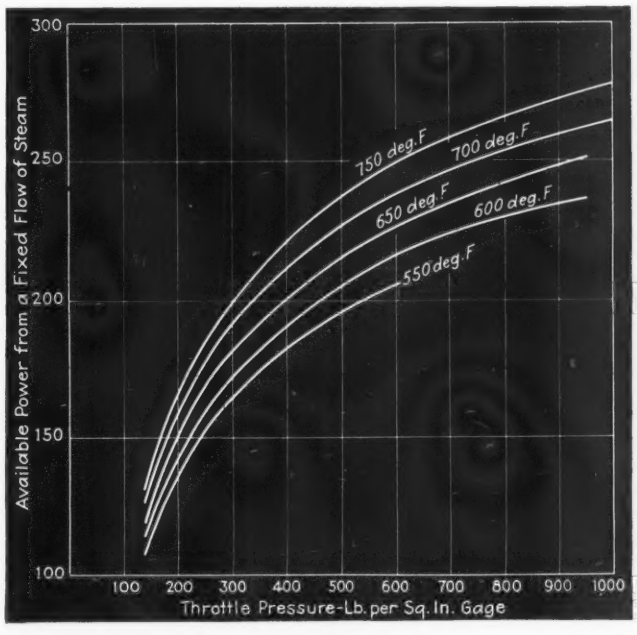
In the condensing plant, about the best which can be done is to recover part of the heat C, while the industrial plant can use the heat B and in many cases, dependent upon the process application, can recover part of the heat C.

Summarizing and giving values for the areas, the comparison is:

	Condensing Plant, Fig. 1 B.T.U.	Industrial Plant, Fig. 2 B.T.U.
Heat delivered to turbine, area $A+B+C$	1,279	1,279
Heat converted to power, area A	289	125
Useful heat recovered from exhaust steam leaving turbine		
Fig. 1, area C	69	960
Fig. 2, area B		
Total Heat Useful		
Fig. 1, area $A + C$	358	1,085
Fig. 2, area $A + B$		
Heat Wasted, per lb., steam		
Fig. 1, area B	921	194
Fig. 2, area C		
Proportion of heat used, per cent	28%	85%

Figs. 3, 4 and 5 compare the fuel used. The total area of each figure is proportional to the fuel burned, assuming the efficiency of heat transfer from fuel to steam to be the same in each case. Each figure represents a power production of one kilowatt-hour. Fig. 3 is made for the condensing turbine referred to above. Fig. 4 is made for the non-condensing turbine previously mentioned. Fig. 5 shows a set-up under which one kilowatt-hour is made by the condensing machine illustrated by Fig. 3 and, in addition, process heat requirements, in the same amount as furnished by the non-

Fig. 6—Relative power available from a fixed flow of steam with various pressures and temperatures for a back pressure of 30 lb. gage



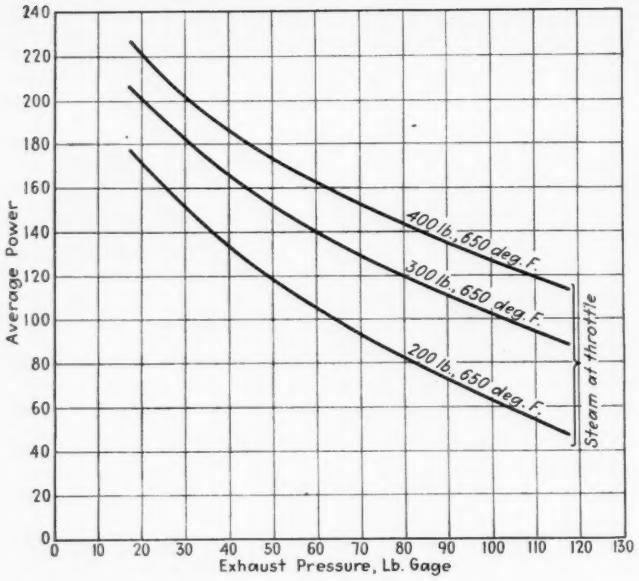


Fig. 7—Effect of exhaust pressure on relative power available from a given flow of steam

condensing machine (Fig. 4) are supplied directly from the boilers, no by-product power being made.

The heavily shaded areas indicate the fuel converted to power, the unshaded areas represent fuel the heat of which is not used, while the lightly shaded areas indicate the fuel used to supply process heat requirements. The length of each figure is proportional to the total area of the figure and the total fuel burned.

It is apparent from a casual inspection of these diagrams that the assumed operating conditions would need to be materially different before the fuel wastes of Fig. 3 or Fig. 5 would be reduced to that of Fig. 4. The total fuel consumed to furnish both power and process heat cannot be the same until the wastes for Fig. 5 and Fig. 4 are equal. Evidently considerable heat waste could be added to Fig. 4 before the fuel for that case would be as much as in Fig. 5, under which conditions the fuel used in the two cases would be equal.

One factor of considerable economic influence in applying by-product power generators is the relative amounts of process heat and power used by the plant. This ratio has certain determinable limits in each particular plant. These limits, properly considered with the other existing conditions, materially affect the physical specifications of a system for heat and power supply.

Several variations in steam conditions may be used effectively to adjust the power output of the turbine per unit of process heat to the amount determined by the economics of the situation. The pressure of the entering steam may be raised, or its temperature may be increased without a change in its pressure, or both temperature and pressure of turbine throttle steam may be changed. Most effective of all to increase power output is a decrease in the pressure of the exhaust.

None of these changes, reasonably used, materially affects the efficiency of the turbine as a machine to unload heat from a pound of steam and convert it into power. A larger amount of power from each unit weight of steam results from more heat being *made available* for conversion into power.

The influences of pressure and temperature changes at the turbine throttle upon the available power output is illustrated by the curves of Fig. 6. Each curve is drawn for a constant temperature of the turbine inlet steam, the horizontal scale representing the pressure of the steam and the vertical scale being proportional to the power available from a constant weight of inlet steam expanded through a non-condensing turbo-generator exhausting at 30 lb. pressure.

Inspection of these curves clearly shows the relative importance of temperature and pressure. It will be readily seen that inlet temperature has a considerable effect upon power output. For instance, the power available with 460 lb. pressure and 650 deg. is as much as from 540-lb. pressure, 600-deg. steam.

The power available from a definite amount of steam is influenced to a greater extent by changes in the turbine exhaust pressure than by changes of the initial steam conditions. Fig. 7 illustrates this. Each curve is made for a fixed initial condition and shows the power available from a constant weight of steam expanded through a non-condensing turbo-generator to the exhaust pressure indicated on the horizontal scale. A small reduction in exhaust pressure is seen to be as effective for increasing power output as a considerable increase in initial pressure would be. For instance, a decrease of exhaust pressure from 37 lb. to 20 lb. with 200 lb. initial pressure is as effective in raising power generation as an increase of initial pressure from 200 lb. to 300 lb. would be with no change made in exhaust pressure.

These curves show clearly that it is a mistake to allow the matter of initial steam pressure to overshadow the importance of temperature at the turbine throttle and pressure at the exhaust. Either of the latter may be more effective to produce the desired power from the process steam used than is throttle pressure.

At the same time, it must not be forgotten that developments in the practice of higher pressure steam generation have enlarged the field for the profitable generation of by-product power. It has made the application of non-condensing power generators practicable where the exhaust pressure must be relatively high by reason of the design of existing process machinery, piping, etc., the replacement of which would be excessive in cost, or by reason of process temperature demands.

Heat for the buildings and manufacturing processes must be provided, and for this reason most plants have to have boilers and must buy fuel. This heat must be furnished to the processes at pressures and temperatures within limits fixed by the physical limitations of equipment and the chemical requirements of processing.

Moisture and superheat conditions are of considerable importance in their effect upon power generation, besides frequently being a pertinent manufacturing consideration.

Fig. 6 shows that, for a given back pressure, various combinations of pressure and temperature at the turbine throttle will give the same available power from a given flow of steam. For example, the following combinations are equivalent in this respect: 300 lb. and 750 deg., 340 lb. and 700 deg., 400 lb. and 650 deg., 460 lb. and 600 deg.

However, each of these various combinations will give a different exhaust condition. Therefore, where a certain exhaust condition is necessary, it must be considered before the correct throttle conditions can be chosen.

The matter of steam pressures and temperatures is best considered in connection with actual plant studies. Two future articles will show how the principles here outlined have been applied to actual plants.

AIR CONDITIONING

FOR HOOVER DAM CONCRETE TESTS

THE Bureau of Reclamation of the Department of Interior has established concrete testing laboratories at Denver, one in the Federal Building and one in a rented building on Welton St., for the purpose of testing the concrete to be used in the Hoover Dam. In such a large mass of concrete as that to be poured at the dam, the concrete will remain perfectly saturated until it is set. Consequently, the specimens must be cured in room conditions that will keep them similarly saturated until the concrete has set.

To accomplish this, the York Ice & Machinery Corp. reports that air conditioning systems have been provided that will automatically maintain a temperature of 70 deg. at 100 per cent humidity in all but one of the concrete curing rooms of both buildings. The exception is a room, in the Federal Building, which is maintained at 70 deg. and an optional humidity of between 50 and 100 per cent. The allowable variation in these conditions is 2 deg. in temperature and 3 per cent in humidity.

In the Federal Building laboratory there are four curing rooms: Room 19, 32 ft. 5 in. x 8 ft. 7 in. x 8 ft. high; Room 19-*G*, 22 ft. 7 in. x 21 ft. 8 in. x 8 ft. high; Room 19-*E*, 10 ft. 6 in. x 7 ft. 6 in. high, and Room 19-*F*, 12 ft. 6 in. x 10 ft. 6 in. x 7 ft. 6 in. high. The Welton St. laboratory has one storing room, which is approximately 35 ft. square and 8 ft. high. Samples cured in these rooms vary in size from 8 in. in diameter and 16 in. long to 36 in. in diameter and 72 in. long.

In the Federal Building laboratory three rooms require cooling, heating and humidifying. The fourth requires, in addition, dehumidifying. Ceiling type spray units are installed, which include a complete assembly of air washer, refrigerant coils and control, electric heaters, pumps and fans. Excess humidity is supplied by means of compressed air type atomizing nozzles.

The refrigerating equipment consists of a self-contained unit supplying float-controlled air washer coils in each room. Each coil is equipped with a suction-pressure regulating valve and a magnetic liquid-valve. Coils in Rooms 19 and 19-*G* also have magnetic suction-line valves. Heating is effected by means of electric strip heaters in the outlets of the air conditioning units.

In the rooms that are to be maintained at 100 per cent relative humidity, the suction-pressure regulators are set to maintain 70-lb. pressure in the refrigerant coils. In Room 19-*E* the suction pressure is varied to give the desired dew point for the condition which is to be maintained. There is a suction-pressure switch at the machine, which controls a two-speed-motor starting switch. When the suction pressure is above 40 lb. at the machine it will operate at high speed, and when the suction pressure drops to 40 lb., it will operate at low speed.

In the control diagram, *P*, is a hand-starter, controlling the motor-driven pump on the spray unit. The fan motor on the unit is controlled by a hand-starter *F*. While the room is in use the fan and pump are operated continuously.

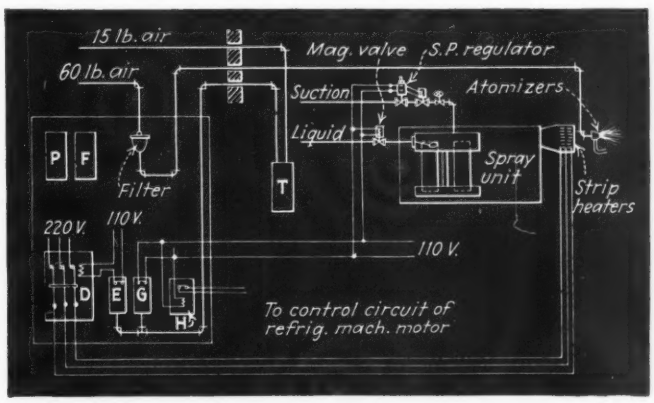
The automatic devices are operated with compressed air at 15-lb. pressure. The compressor which furnishes this air also supplies air at 60-lb. pressure to the atomizers.

With room temperature of 70 deg., thermostat *T* will maintain pressure in the control line of approximately 5 lb. With rising temperature in the room, the air pressure increases, and at 7 lb. switch *G* closes the circuit and opens the magnetic valves in the suction and liquid lines to the air-conditioning unit. At the same time motor control relay *H* closes and calls for refrigeration. As the room is cooled down from 70 deg. the pressure in the control line drops to 5 lb. and switch *G* opens the circuit, closing magnetic valves, and opens the refrigerating machine circuit. If the room temperature drops below 70 deg. the pressure in the control line drops, and at 3 lb. pressure switch *E* closes the circuit, and magnetic switch *B* turns on strip heaters in the air-conditioning unit. As the temperature rises the pressure in the control line rises, and at 5 lb. pressure switch *E* opens and shuts off the heat.

Any one of the four rooms requiring refrigeration will start the compressor through relay *H*, and the compressor will operate as long as a single room needs cooling. When only one or two rooms need refrigeration, the compressor operates at low speed, as described previously.

In the optional humidity Room 19-*E*, the automatic control equipment is the same as shown on the diagram, and the operation will be the same when this room is maintained at 100 per cent humidity. When a humidity less than 100 per cent is desired, additional controls are required, one set for a humidity between 50 and 70 per cent, another for between 70 and 95 per cent. A dew point thermostat, or wet bulb thermostat, controls the refrigeration, and the dry bulb thermostat controls the strip heaters, to prevent the dry bulb temperature from getting too low. The Welton St. Laboratory has one spray type air conditioning unit. Operation of the automatic equipment is virtually the same as for rooms 19, 19*F* and 19*G* except that the refrigerant coils are equipped with a high-pressure float valve and the magnetic valves have been eliminated.

Diagram of control for air conditioning system



LIGHTER OIL MAY MEAN COOLER BEARINGS

Tests on four lubricating oils show why a bearing sometimes operates at lower temperatures with a light-bodied oil than with a heavier lubricant

By JAMES I. CLOWER

Assistant Professor of Machine Design, Virginia Polytechnic Institute

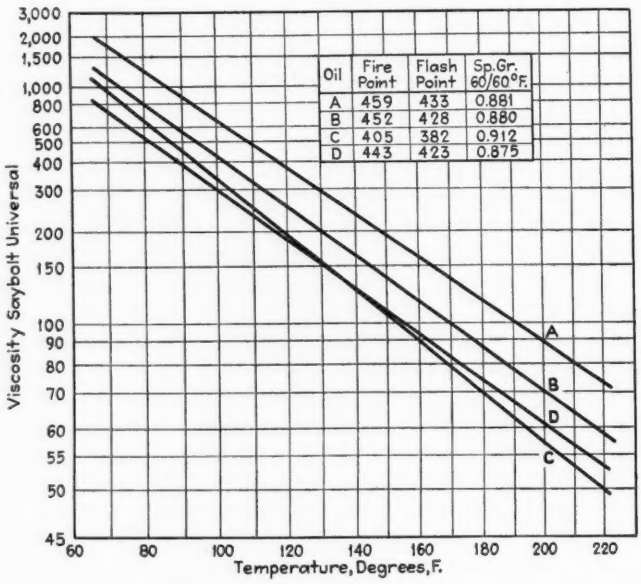
IN MANY instances an attempt is made to correct lubrication difficulties simply by substituting a heavier-bodied oil for a lighter one already in service. If an oil is too light in body, bearings burn out, pistons sieze, cylinder walls score, and many other annoying things happen. With these facts known, it is easy to work backward to the conclusion that if a thin oil is bad, a thick oil must be good, and that the thicker the oil the better it must be. Such reasoning is, of course, fallacious, as some engineers have discovered to their sorrow.

A journal should not come in contact with its bearing, but should be supported on a thin film of oil. The shearing resistance or fluid friction which the oil particles in the film offer measures the efficiency of the lubricant. A cardinal principle underlying all lubrication is to provide the thinnest (least viscous) oil that will stay in place and at the same time prevent metal-to-metal contact of the rubbing surfaces.

It is imperative that the viscosity of an oil be such that an ample margin of safety be provided against metallic contact while the machine is in operation. Hence, viscosity is of great importance when selecting an oil. Moreover, this viscosity should not be taken at any arbitrary temperature such as 100, 130 or 210 deg. F., but at the temperature at which the oil is used. It is not the temperature of the oil in the well or the sump that is important, but the actual temperature existing in the oil film between the bearing surfaces.

The viscosity of mineral oil changes rapidly with temperature, and this rate of change is not the same for all oils. It frequently happens that one oil is less viscous than another at some arbitrary temperature, but more viscous at some other temperature. This fact was convincingly demonstrated to me recently by some tests I made on lubricants.

The results of these tests show: (1) Under certain operating conditions a light-bodied oil may provide a greater factor of safety against film rupture than an oil of heavier body. (2) Two oils of approximately the same viscosity do not offer the same shearing resistance.



Oil	Fire Point	Flash Point	Sp.Gr. 60/60°F.
A	459	433	0.881
B	452	428	0.880
C	405	382	0.912
D	443	423	0.875

Fig. 1—Temperature-viscosity curves for four different oils

In Fig. 1 are shown the temperature-viscosity curves for the oils used. Oils *A, B* and *D* have paraffine bases, while *C* has a mixed base of paraffine and napthene. Oil *A* is known to the trade as a heavy oil; *B* is a medium oil; and *C* and *D* are light oils. The terms heavy, medium and light refer to oil body or viscosity. All four oils were commercial automotive oils.

Table I was compiled from enlarged graphs of Figs. 1 and 2. A study of this table is of interest. For instance, a column headed 100 shows that the operating temperature of the bearing with oil *A* in use was 120 deg. F., but only 79 with oil *D*. More important than this is the fact that the light-bodied oil *D* possessed a heavier body at this speed, thus insuring a greater factor of safety against film rupture. This explains how it is sometimes possible to relieve bearing trouble by substituting a light-bodied oil for one much heavier, which is sometimes done by lubricating engineers to the amazement of the operating personnel.

The last column of the table shows that for a peripheral speed of 500 ft. per min. that the reverse of the above is true, that is, the heavy-bodied oil provided the greater factor of safety. The temperature is still,

Table I—Relation between temperature, viscosity and journal speed

Oil		Journal Speed in Feet per Minute				
		100	200	300	400	500
A	Deg. F.	120	129	139	148	157
	Vis.	380	300	240	200	170
B	Deg. F.	103	115	127	139	150
	Vis.	400	290	220	170	135
C	Deg. F.	90	105	119	134	147
	Vis.	440	285	190	135	105
D	Deg. F.	79	95	110	126	141
	Vis.	540	340	240	170	125

however, in favor of the light-bodied oil. This fact indicates that the frictional power loss is less with the light oil in use.

Fig. 2 shows that considerable differences existed between the operating temperatures of the bearing with the two light-bodied oils in service. As shown in Fig. 1, the average viscosity of these two oils is approximately equal, being the same at around 130 deg. F. With oil D in use, however, the operating temperature under the same operating conditions was approximately 8 deg. F. less than with oil *C* in service. This would indicate that properties other than viscosity affect or influence the fluid resistance of oil films.

These tests were made on a journal bearing $1\frac{3}{32}$ in. in diameter and 5 in. long. To measure the oil-film temperatures, six thermocouples were spaced equally in holes around the center of the bearing and the temperature read on a potentiometer.

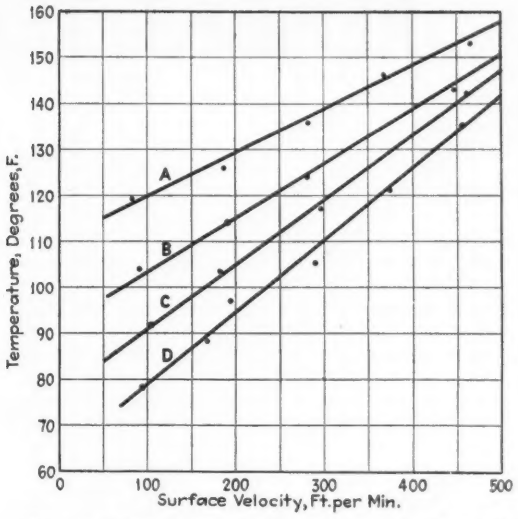


Fig. 2—Temperature-velocity curves for four different oils with bearing loads of 65 lb. per sq.in.

MONO-SODIUM PHOSPHATE TREATMENT

By WILLIAM J. RYAN
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New York City

MY ARTICLE in *Power* for December, 1932, gave formulas for figuring the amounts of lime, soda ash, trisodium phosphate and di-sodium phosphate required for feed-water treatment. At the request of a reader, I shall here add the formula for mono-sodium phosphate.

There are two formulas for figuring the amount of mono-sodium phosphate, depending on how the water analysis is expressed. One form of analysis would look like the following:

	Parts per million
Total hardness (as $CaCO_3$)	125
Calcium hardness (as $CaCO_3$)	91
Magnesium hardness (as $CaCO_3$)	34
Alkalinity (as $CaCO_3$)	96
Sulphates (as SO_4)	28
Chlorides (as Cl)	18
Carbon dioxide (CO_2)	30

The theoretically required amount of commercial mono-sodium phosphate ($NaH_2PO_4.H_2O$) required to react with the hardness in this water can be figured thus in pounds per 1,000 gallons:

$$\text{POUNDS MONO-SODIUM PHOSPHATE} = \frac{\text{Total hardness as } CaCO_3 \times 0.92}{120}$$

$$= \frac{125 \times 0.92}{120}$$

$$= 0.96 \text{ lb. per 1,000 gal.}$$

As was explained in the December article, the water analysis may also be reported in the "ionic' form, in which the metallic elements and the radicals are reported separately. The foregoing analysis could be reexpressed in this form as follows:

	Parts per million
Calcium (Ca)	36.4
Magnesium (Mg)	8.3
Sodium (Na)	12.
Bicarbonate (HCO_3)	117
Sulphate (SO_4)	28
Chloride (Cl)	18
Carbon dioxide (CO_2)	30

From this form of analysis the required mono-sodium phosphate can be figured thus, in pounds per 1,000 gallons:

$$\text{POUNDS MONO-SODIUM PHOSPHATE} = \frac{(Ca \times 2.3) + (Mg \times 3.8)}{120}$$

$$= \frac{(36.4 \times 2.3) + (8.3 \times 3.8)}{120}$$

$$= 0.96 \text{ lb. per 1,000 gal.}$$

The amount used in actual practice is determined by experience in each case and is usually slightly larger than the theoretically calculated quantity.

REHEAT TEMPERATURE

AUTOMATICALLY CONTROLLED

Complete anticipatory control system governs reheat temperatures over a wide variation in station demand by desuperheating and regulating steam-flow admission to steam reheater

STATION A of the Pacific Gas and Electric Company has three 1,400-lb. boilers and two 50,000-kw. vertical compound turbines. The exhaust from the high-pressure turbines is reheated before going to the low-pressure units. Two systems were considered for reheat temperature control, one to vary the amount of heating surface of the steam reheater by flooding with condensate and the other to bypass some of the steam to be reheated. The first plan was rejected because of the expected difficulties in preventing leaks.

Automatic control by the by-pass method was installed after a number of months of manual operation had shown the system to be satisfactory. This reheat system consists of a steam reheater in series with a flue-gas reheater constructed as part of the boiler. The steam reheater, which is supplied with saturated steam is located in a vertical position above the boiler at a height sufficient to allow the condensate to drain back to the boiler drum. Fig. 4 shows the arrangement of the reheaters and connecting piping. Valves in the steam and water lines connecting the steam reheater to the boiler drum are open at all times. Desuperheating when necessary is accomplished by bypassing some of the steam through No. 1 feed-water heater.

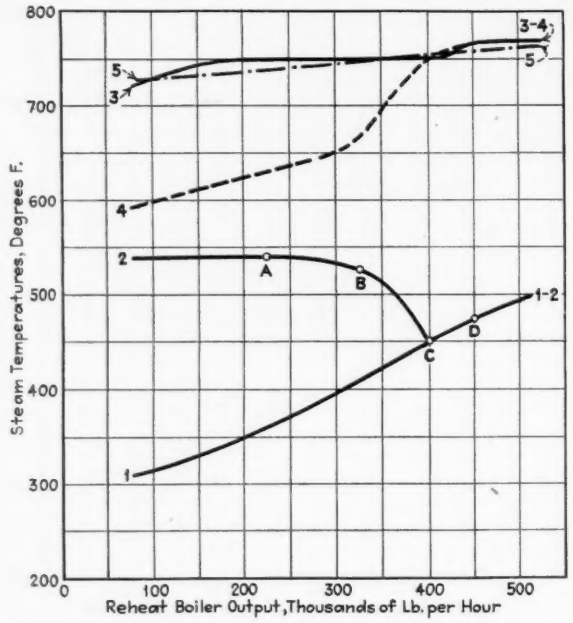


Fig. 1—Steam temperature curves of the station under automatic reheat control. Detailed explanation in the text

Exhaust from the high-pressure turbine first passes through the steam reheater, then through the flue-gas reheater and to the low-pressure turbine. Regulation of reheat temperature is obtained by operation of the by-pass valve *A*, the inlet valve *B* to the steam reheater, and the outlet valve *C* of No. 1 feed-water heater.

As the load on a reheat boiler increases, the reheat temperatures tend to increase and the first operation in controlling this temperature is to open the steam-reheater by-pass valve *A* and bypass a part of the high-pressure turbine exhaust around the steam reheater. After this valve is fully opened, the reheater inlet valve *B* starts closing, forcing more of the steam through the bypass. If, after valve *B* is fully closed, the temperature continues to rise, No. 1 feed-water heater outlet valve *C* is opened. This later operation desuperheats a portion of the steam before it enters the flue-gas reheater. All these valves are motor-operated, and before automatic control was installed these operations were performed by the boiler operator who observed the indicated final reheat temperature and adjusted the valves through push-button control.

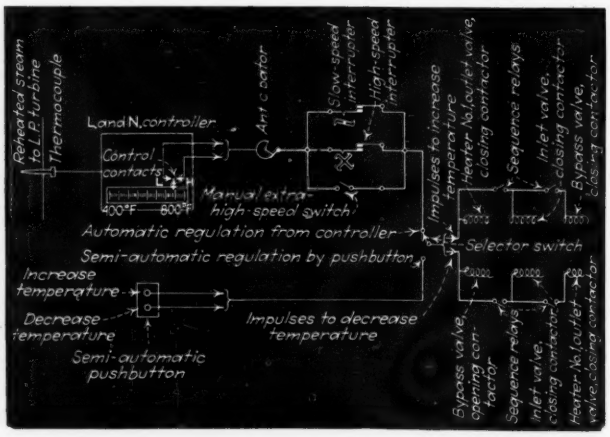


Fig. 2—Diagram of reheat control showing the method of transmitting impulses to the motor-operated valves and the sequence relays governing the operation. The anticipator functions to prevent hunting

Desuperheating by the use of No. 1 feed-water heater was much simpler and involved fewer problems than if accomplished by spraying water into the steam. No. 1 feed-water heater is used for this purpose in emergency when the high-pressure turbine is out of service and it is desired to operate the low-pressure turbine. High-pressure steam passing through the low-pressure turbine control valve and orifice (which are in use only when operating in this manner) then is desuperheated by No. 1 feed-water heater. Under these conditions the steam reheater is bypassed.

It was a simple matter to apply automatic reheat control to the existing equipment. A potentiometer, installed to indicate the temperature of the steam leaving the flue-gas reheater, was used as the master instru-

AT HIGH-PRESSURE STATION

By C. E. STEINBECK
Department of Engineering, Pacific Gas and Electric Co.

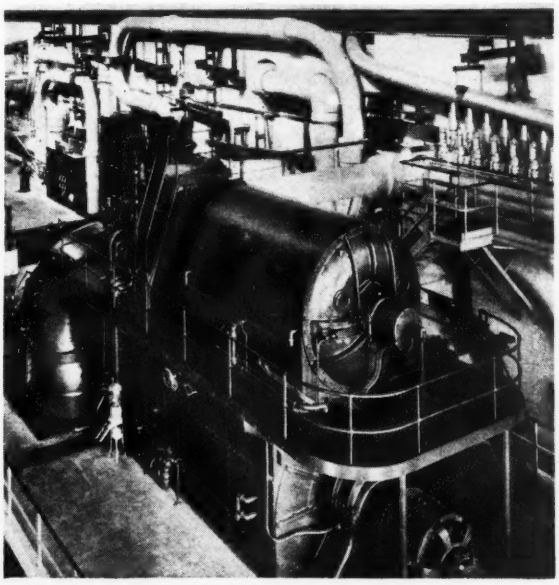


Fig. 3—One of the two 50,000-kw. vertical compound turbines

ment to actuate the various parts of the control system. Fig. 2 is a schematic diagram of the reheat temperature control; the thermocouple and the potentiometer have a range of 400 to 800 deg. F.

When the reheat temperature is fluctuating a means is provided for adjusting the regulating-valve positions so that the temperature may be brought back to standard with a minimum of hunting. This is accomplished by the use of high- and low-speed interrupters and an anticipator all of which receive their impulses from contactors installed in the case of the potentiometer. These contactors are closed when the temperature is off standard.

An auxiliary contact, not shown on the diagram, selects either a high- or a low-speed interrupter depending on the temperature. When this is more than plus or minus 8 deg. from the standard, the high-speed interrupter is in operation and when brought within this range the slow-speed interrupter takes over control. As the temperature approaches the desired point, the anticipator functions to eliminate all impulses. Should any abnormal condition arise where more speed of operation is required a switch may be closed by hand cutting out all interrupter action and allowing sequence operation of the valves in a minimum of time. To go from one extreme position of the control to the other requires 143 sec. when this latter method is used.

There are three ways in which the regulating valves may be controlled, two of which are indicated by the

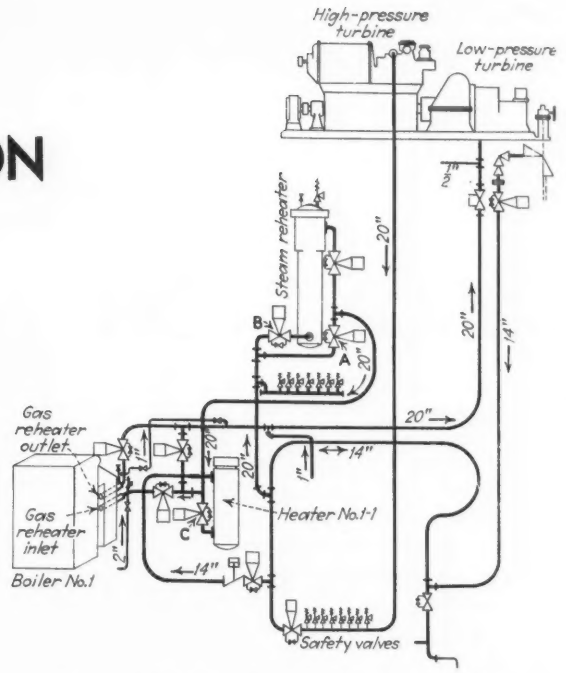


Fig. 4—Diagram of the arrangement of the reheaters and station piping for the system

diagram. A selector switch marked "Automatic," "Semi-automatic," and "Push Button" is provided. When the switch is in the "Automatic" position, impulses are transmitted from the controller for automatic sequence operation of the valves; when in the "Semi-automatic" position, sequence control is governed by push button; and when in the "Push Button" position, the valves may be operated individually. No change was made in the motor equipment of the valves. Limit switches on the motors are used to operate the sequence relays.

Signal lights indicate the position of the selector switch, the open or closed position of each valve, and various other items necessary for the information of the operator. The standard temperature which is desired is maintained by an adjustable front-setting indicator on the temperature scale of the potentiometer. The allowable variation before the automatic high-speed contact of the interrupter closes is also adjustable.

The accompanying curve, Fig. 1, shows actual temperatures when operating one reheat boiler only with its corresponding turbine. Curve 1 shows the temperature of the steam entering the live-steam reheater; curve 2, the steam leaving the live-steam reheater; and curve 3, the steam leaving the flue-gas reheater. Curve 4 shows the temperature of the steam leaving the flue-gas reheater with the live-steam reheater out of service and curve 5 the primary superheat. Point *A* of curve 2 shows the steam flow at which valve *A*, Fig. 4, starts to open and point *B* is when this valve is fully opened and valve *B* starts to close. Point *C* is where valve *B* is fully closed and desuperheating is started by opening valve *C*. At *D*, valve *C* is fully opened.

Under normal operation, the most economical results are obtained on the station by a distribution of load between the two reheat and the standard boilers (see *Power*, Nov. 17, 1931, page 697, for complete details).

The reheat boiler then operates so that the final reheat temperature falls on the flat part of curve 3 and the automatic regulation maintains the temperature within 2 deg. plus or minus.

By E. ZETTERQUIST
Turbine Engineer,
Westinghouse Electric & Mfg. Co.

BURLINGTON STATION

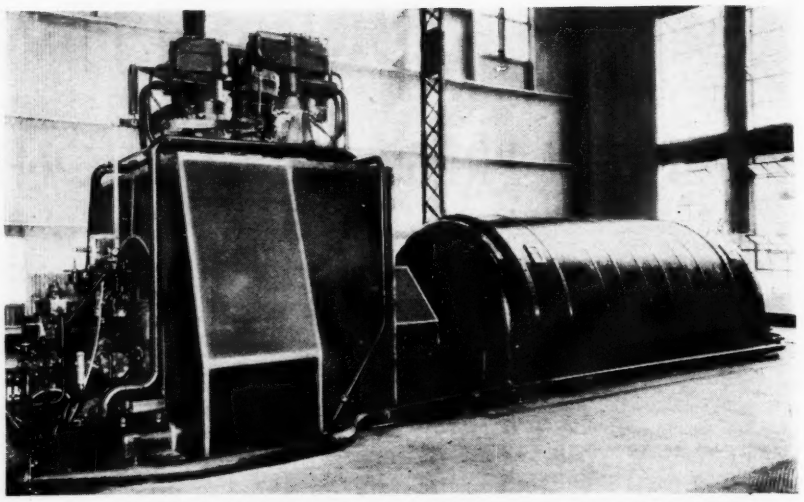


Fig. 1—New 18,000-kw., 3,600-r.p.m. turbine generator at Burlington

MODERNIZED BY HIGH-PRESSURE "TOP"

The 650-lb. pressure, 850-deg., 18,000-kw. unit added to the Burlington station of the Public Service Electric & Gas Co. exhausts to three 12,500-kva. units that operate at 190-lb. pressure. This article, the first of two on this station, discusses the general heat balance and emergency features

RETIREMENT from regular service of 200-lb. pressure, 500-deg. plants, which higher pressures and temperatures may have rendered obsolete, necessarily involves the addition of equivalent new generator capacity to the system, and usually includes new boilers, prime movers, condensers and auxiliaries. Where the old prime movers are mechanically unsound, such replacement is about the only alternative. But the prime movers in most older plants are capable of prolonged and satisfactory service with comparatively small maintenance. Under such conditions, the alternative of modernizing the old plant by superimposing a high-pressure turbine on the existing low-pressure units is worthy of careful consideration.

A remodeled plant has the disadvantage of poorer efficiency as compared with an entirely new installation. This loss results from lower stage efficiencies in the low-pressure turbines, poorer efficiencies of their generators, increased mechanical losses and loss due to pressure drop in the high-pressure-turbine exhaust header. On the other hand the reconstructed plant possesses several distinct advantages.

(*a*) The initial investment is low.

(*b*) The capacity of the system is increased by the output of the new high-pressure unit.

(*c*) The old prime movers, which because of their high fuel consumption would otherwise be obsolete, are maintained in regular service.

(*d*) Flexibility of operation is greater. An entirely new installation of either the single-cylinder or tandem-type prime mover will require a complete shut-down in case of repairs. The reconstructed plant allows individual operation of the low-pressure turbines during inspection or repairs to the high-pressure element. Such operation is also possible in case of trouble with the high-pressure boilers, provided the low-pressure boilers are maintained for standby service. This greater flexibility of operation inherent in the reconstructed plant allows a reduction in the over-all reserve capacity on the system and reduces operating expenses.

(*e*) With an efficiency ratio some 8 or 10 per cent lower than that for a complete new installation, the reconstructed plant admits of an increase in throttle pressure without the necessity for reheating. Applying this difference in efficiency ratio, the reconstructed plant operating on 1,250 lb. pressure and 850 deg. F. is found to have approximately the same percentage moisture in the low-pressure exhaust as a new installation operating on 650 lb. pressure and 850 deg. F. If these latter conditions are considered satisfactory for a new plant with shielded high-speed exhaust blades, the former conditions can be considered equally satisfactory for the reconstructed plant where the blade speeds are sufficiently low to render the destructive action of the moisture almost negligible. An increase in throttle pressure from 650 lb. to 1,250 lb. at a temperature of 850 deg. F. and 200 lb. back pressure, without reheating, would increase the high-pressure element capacity about 55 per cent.

Before remodeling, the Burlington plant of the Public Service Electric & Gas Company of New Jersey consisted of three 12,500-kva. turbine-generator sets operating on 190 lb. pressure and 535 deg. F. total temperature. As reconditioned, the plant is now operating on 650 lb. pressure at a full-load temperature of 850 deg. F. The pressure in this case was limited to 650 lb. to form a basis for contemplated future extensions using large complete expansion turbines with high-speed exhaust blading.

The revised station layout is shown schematically in Fig. 2. The new 3,600 r.p.m. high-pressure unit is de-

signed to develop its full rated load of 18,000 kw., 80 per cent power factor when supplying sufficient steam to the three low-pressure turbines at 205 lb. back pressure for these latter to carry their combined maximum load of 37,500 kw. at unit power factor. Normally the governing is done by the high-pressure turbine alone, the four turbine elements thus forming a quadruple-compound unit.

Steam is bled simultaneously from all three low-pressure units to heater No. 2 and through a reducing valve to the deaerator. Similarly the No. 1 heater takes its steam simultaneously from units Nos. 1 and 2. This common heater system was adopted in preference to individual heaters for each low-pressure turbine because of its greater simplicity and lower cost.

Such bleeding from two or three separate turbine elements requires fairly close agreement of pressures to prevent excess bleeding from one or two elements. While the effect on the over-all performance of the station from unequal bleeding should be practically nil, assuming equal efficiencies of the low-pressure elements, it will nevertheless cause a shifting of load between the elements, with consequent lowering of the station capacity if it is assumed that this is limited by the ratings of the generators of the low-pressure turbines.

The new high-pressure turbine is equipped with a back-pressure regulator so that, if desired, the station may be operated with constant inlet pressure to the low-pressure turbines. For such operation, and in case the low-pressure turbines are operated alone on either the new or old boilers, the load on each individual low-pressure turbine is controlled by its own governor. Thus the load division may be such that the pressure in one turbine is sufficiently high relative to the others not only to supply all the necessary steam to the heater, but to cause cross-flows to the other turbine elements as well. Cross-flow is prevented by check valves located in each bleeder line, adjacent to the turbines, which valves also serve to prevent overspeeding due to reverse steam flow from the pipe lines in case of loss of load.

For operation with variable back pressure, the back pressure regulator on the high-pressure turbine acts as a load limiting device by controlling the back pressure to a predetermined maximum of 205 lb. per sq.in. This applies in particular to operation of the high-pressure turbine with only two low-pressure turbines in service, or, in case of emergency, with one low-pressure turbine. Under these conditions the capacity of the high-pressure turbine is sufficiently large to allow heavy overloading of the low-pressure elements in case of a sudden application of load. In addition to the back-pressure regulator, the back-pressure line between the high-pressure turbine exhaust and the main gate valve is equipped with a 12-in. relief line to atmosphere for protection in case of an attempt to operate the high-pressure turbine with the gate valve closed. The header on the low-pressure side of the gate valve is protected by relief valves on a 16-in. line, which supplies steam directly from the high-pressure boilers through a combination pressure reducing valve and desuperheater when operating the low-pressure turbines alone on high-pressure steam. A hand-controlled, 5-in. free-exhaust line is connected to the 12-in. relief line on the high-pressure side of the main gate valve. This permits starting the high-pressure turbine when the low-pressure turbines are in operation.

A thermostatically controlled desuperheater is installed in the high-pressure turbine exhaust line adjacent to the main gate valve. It is adjusted to limit the inlet temperature to the low-pressure turbines to a maximum of 625 deg. F. This corresponds to a temperature slightly in excess of 500 deg. F. at the impulse chambers of the low-pressure turbines, where the cast-iron cylinder parts come in direct contact with the steam. Normally the desuperheater will function only in case of extreme light-load operation and with one low-pressure turbine tied in with the high-pressure unit.

A comparison of the efficiency between steam-driven and motor-driven auxiliaries disclosed a sufficiently large saving in favor of the latter to permit the substitution of motor drives throughout. The change included replacing the steam-driven exciter sets with a direct-connected exciter on each low-pressure turbine generator shaft. The only steam-driven auxiliaries in the station, as it is now operating, are a spare boiler feed pump and a spare house service pump.

The over-all heat consumption of the remodeled plant is in the order of 15,000 B.t.u. per kw.-hr. in contrast to a heat rate of about 24,000 B.t.u. per kw.-hr. before the program of reconstruction was carried out. The saving in fuel consumption is nearly 40 per cent in addition to which the capacity of the plant has been increased by 18,000 kw., or nearly 50 per cent. The results are representative of what may be accomplished, at a comparatively small expenditure, in conjunction with a great many of these older installations, which, although mechanically sound, have become somewhat obsolete.

The second article on Burlington will deal with details of the turbine.

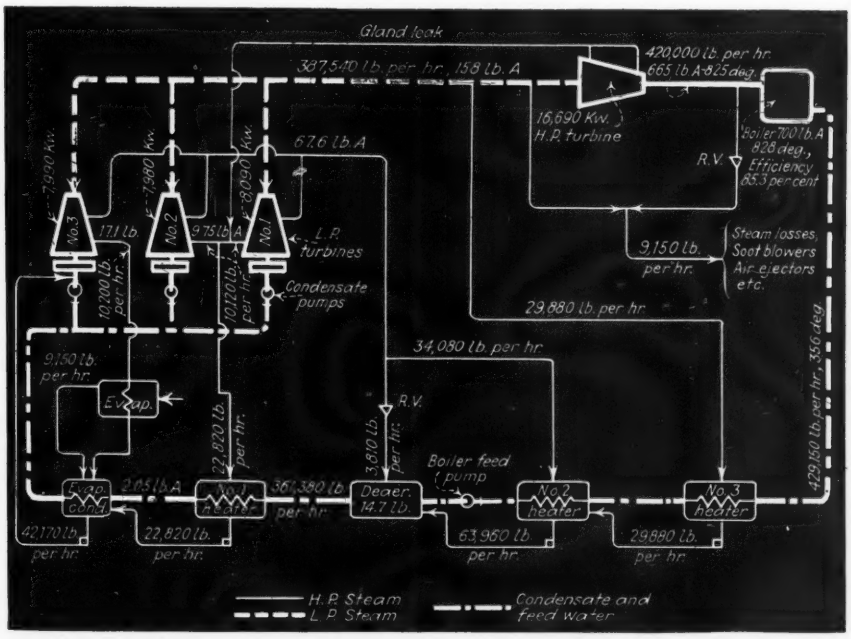


Fig. 2—Heat balance diagram after reconditioning. Total load 40,750 kw., aux. load, 4,075 kw., net load 36,675 kw. Heat rate 15,000 B.t.u. per kw.-hr.

BUYING ELECTRICITY IS AN ART

By JOHN M. ACHESON

Engineering Analyst,
National Biscuit Company

"Make or Buy," "How to Make,"—these are the main themes of the power song. Another, equally important, but long neglected, is "How to Buy." Of this the author writes from a unique experience with the power problems of the many National Biscuit plants

IN TWO senses the purchase of electricity for industrial use is an art. One side of the problem that has been long and wisely considered by many engineers is expressed in the question, "Shall we buy or make?" Assuming the correct answer to be "Buy," as must sometimes be the case, the second problem is, "How shall we buy?"

To many engineers this second will seem a strange question. With rate schedules fixed in most localities, they see no "art" in buying beyond signing the contract, making the connection, exercising reasonable care in the use of current—and paying the bills.

And in so over-simplifying the problem they repeat the mistake that in the national aggregate, costs industry millions of dollars annually. To avoid this error and salvage these losses engineers must learn to recognize that the buying of electricity is an art demanding skill equal to the best applied in power generation.

The primary purpose of this article is to acquaint the reader with some of the questions to be faced when electricity is purchased from a utility company and to indicate the extent of the consumer's protection under the terms of most electricity contracts. Essentially, most industrial electricity rates consist of two charges: the "demand charge" and the "energy charge." In addition the various rate schedules often incorporate other charges based on power factors, fuel costs, etc.

The A B C of Rates

The demand charge of an electricity rate schedule is intended to cover the utility company's fixed costs. Its amount depends upon the monthly "maximum demand" or "peak load" measured over a period of five minutes or longer. The time period is stipulated in each schedule and falls usually between five minutes and one-half hour. Most utility companies use the half-hour period, which is more advantageous to the consumer.

In making a decision to purchase electricity, it is important to remember that a possible saving can very easily be lost through the stipulations incorporated in schedules governing the recording of "maximum demands" and the charges therefor. A high "maximum demand" is often the result of one or a few peaks caused by an abnormal, and perhaps unnecessary, condition. Many rates are so arranged that the consumer is billed monthly for an entire year on the basis of the "maximum demand" registered during a single abnormal period. The cost of such a peak may reach astonishing proportions. Conversely, the ability to spot and cure such a situation may save large sums with little effort.

Exorbitant demands are very often due to inefficient motor operation and poor power factors. In many cases electrical loads can be staggered to reduce the peaks. Economies in demand charges can often be made by the installation of a "power-demand limitator," whereby part of the load can be automatically disconnected temporarily without interfering with production and thereby keep the demand below a predetermined maximum.

Where the monthly maximum demands are not measured, they are predetermined by the amount of connected electrical load taken from the data on the nameplates of the installed equipment.

The monthly "energy charge" depends upon the actual amount of energy consumed during the month. Practically all schedules are arranged so that as the consumption increases, the unit rate decreases.

In addition to the foregoing charges, an adjustment is very often made to cover fluctuations in the fuel costs of the utility company. This adjustment is based upon the changes in the cost of generating electricity by steam due to changes in the cost of fuel from a definite base price. If the price of coal increases or decreases, the net price for each kilowatt-hour of electric energy supplied will accordingly be increased or decreased by an amount proportional to this change.

Many rates also include penalties for low power factor. Power factor can be improved by the use of synchronous motors, synchronous condensers, static condensers, etc.

In deciding whether electricity should be purchased or made locally, dependability of the service should be most carefully considered. Utility companies usually stipulate in their schedules that, in case their service should be

interrupted or fail, they shall not be held liable for resulting damage. The reliability record of the utility for industrial consumers of the given region then becomes a paramount consideration.

As a rule, utility companies cooperate with their customers by advising them where more advantageous scheduled rates could be used and by helping them to obtain more efficient operation. Most large utility companies have a department that is constantly engaged in checking the customer's consumption records and pointing out to him probable benefits obtainable by buying electric energy under a different available schedule from that under which he is now billed. The greatest asset of a utility is the good-will of its customers, and it must be said that it generally strives to obtain it.

However, there are times when the relations between the utility and customer are strained. In such cases the customer can submit his case to the state utility commission.

This state regulatory commission functions as an arbiter between the utility and the consumer and acts in the interest of both. Every state in the Union, with the exception of Delaware, has a regulatory commission with powers defined by local laws. The jurisdiction of the commission extends over the operations of privately owned utilities, as regards electric light, heat and power, in every state where a commission is established, except in Florida, Iowa, Kentucky, Minnesota, Mississippi, South Dakota and Texas. In Michigan, the Commission's jurisdiction on electric matters is limited.

Commissions usually have very little jurisdiction over municipally owned electric plants.

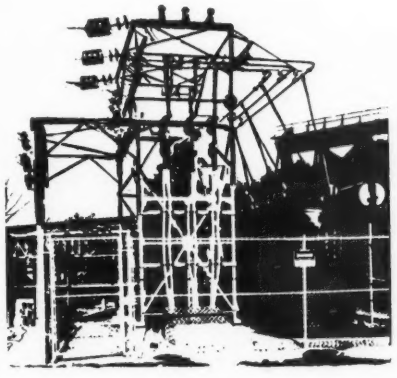
The commission will review any case properly presented and will make decisions in accordance with its regulatory powers. Of course, a consumer always has his constitutional right of court review of the commission's decisions.

Another feature of the state regulatory commission is that utility companies are usually required by law to file their complete lists of schedules and contracts at the state capitol. These are public records, and a consumer can visit the state capitol and inspect the various schedules, to be sure he is obtaining the best possible rate.

Whether the purchase of electricity is actually being made or merely contemplated, it is recommended that the local electricity rate schedules and laws be investigated to make sure that the lowest possible yearly cost is obtained.

Attention in this article has been concentrated on the existing, but much neglected, means of saving money in the purchase of electricity. A similar analysis should be made when deciding whether to buy or to continue the operation of an existing plant. It is necessary to consider not only present generating costs but what they would be if close attention were given to power applications in the factory. It is this cost which must be compared with purchased current, likewise bought and applied with the utmost skill. The following brief remarks will fit both sides of this problem.

First, it must be remembered that when electricity is purchased, a large percentage of the original power plant operating costs will remain, due to the necessity of heating the plant, and particularly if steam is used for process work. Moreover the original investment will, in general, continue to carry fixed charges.



On the application side, electric motor loads should be carefully analyzed. Motors operate at their highest efficiency when they are operating around rated capacity. Furthermore, if a certain load can be handled by a smaller motor, the change will not only result in higher efficiency, but in a lower investment and an improvement of the power factor. These advantages are particularly important where electricity is to be purchased on rates involving a demand charge.

Many cases of high power costs can be traced to the use of improper sized motors for certain loads, to poor belting adjustments, unnecessary shafting, poor arrangement of machinery and improper lubrication. All tend to lower the efficiency and power factors.

Every motor in the plant should be tested to ascertain the amount of the connected load. With this knowledge, and also an understanding of the load requirements, it is possible that motors and loads within the plant can be rearranged to eliminate some motors and fully load others, thereby obtaining higher efficiency and a better power factor.

The problem of illumination in a factory is one of great importance, both as to the cost and effect. The writer has often entered plants using higher wattage lamps than were necessary. On the other hand, it is very important in any factory to have adequate illumination. The study of illumination should be made by an experienced engineer, so that proper lighting will be made available and yet minimize the consumption of electricity.

Distribution systems within the plant should also be checked as to the size of conductors and the length of lines, to see what effect they have on the yearly costs.

To sum up: Analyze applications to get most economical consumption with either locally generated or purchased power. Analyze rates to see how lowest purchase cost may be achieved and to see what it will be. If the decision is to purchase, continue the rate analysis and keep everlastingly at those elements of factory operation that, neglected, boost the cost of purchased power.

Galvanized Cap for Rivet—A novel method of protecting rivet heads from corrosion has recently been developed (U. S. Pat. 1,867,736) which avoids previous difficulties with hot-dip galvanizing. Galvanized members have thus far been used only in comparatively light, bolted structures, in which parts were first galvanized, then fastened together with galvanized bolts and nuts. Riveted structures of galvanized steel have not been used because of the difficulty of protecting the rivet heads against corrosion. The new method follows normal procedure in that galvanized sections are riveted together in the usual way, but afterward a special tight-fitting circular flanged cap of heavy-gage zinc is soldered over the head with a special iron, either gas or electrically heated and designed for use under any conditions. The caps are thus airtight and prevent corrosion of the rivet heads.

SELECTING
THERMAL RELAYS
TO PROTECT THREE-PHASE MOTORS

By H. WILSON
Toronto, Ont.

Several questions here answered frequently confront engineers when they consider proper protection of three-phase motors against overload and single-phase operation with thermal relays. Tests show how to make proper allowance for air temperature, winding connections and other factors affecting thermal-relay operation

▼

PROPER motor protection with thermal relays involves more than selection of a relay with a rating having some arbitrary relation to the nominal rating of the motor. The overload capacity of the motor, the difference in air temperature around the motor and the relay, the characteristics of the motor when operating single-phase and the grouping of the motor windings all bear on the problem.

Motors may be designed to fill the requirements of some special class of service, but most induction motors are of the 40-deg., continuous-rated, general-purpose type, designed to suit average conditions of service. According to the A.I.E.E. standards the limiting temperature as measured by a thermometer at the hottest accessible part of the motor is 90 deg. C. or 194 deg. F. for the class of insulation used in the ordinary induction motor. An allowance of 15 deg. is made for hot-spot temperature, the assumption being that the internal temperature of the windings may go as high as 105 deg. C. with the motor still operating within safe limits.

Ordinary insulating materials, such as various kinds of paper, cotton and insulating varnishes, deteriorate in time even when subjected to temperatures of from 70 to 80 deg. C. If years of trouble-free service are expected from a motor under average operating conditions, a limiting temperature of 80 deg. C. would probably be a safer standard to work to when considering motor protection.

Now, 40 deg. C. or 104 deg. F. is not an ordinary room temperature. Most motors operate in air temperatures of from 20 to 30 deg. C., so that with average conditions and an 80-deg. temperature limit, the 40-deg. motor has still a considerable margin of safety when loaded in excess of its normal rating.

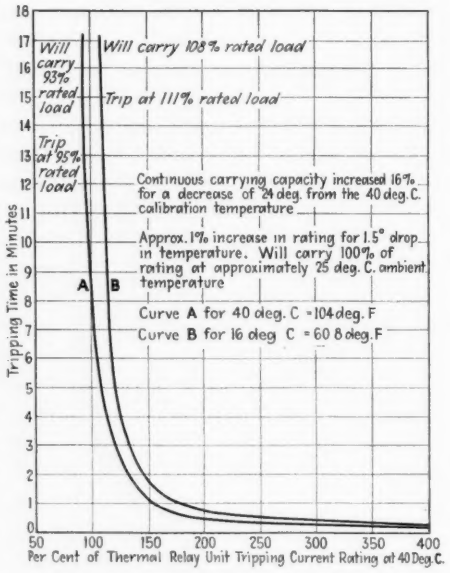

Will carry 108% rated load
Will carry 93% rated load
Trip at 111% rated load
Trip at 95% rated load
Continuous carrying capacity increased 16% for a decrease of 24 deg. from the 40 deg. C. calibration temperature
Approx. 1% increase in rating for 1.5° drop in temperature. Will carry 100% of rating at approximately 25 deg. C. ambient temperature
A
B
Curve A for 40 deg. C = 104 deg. F
Curve B for 16 deg. C = 60.8 deg. F
Tripping Time in Minutes
Per Cent of Thermal Relay Unit Tripping Current Rating at 40 Deg. C.

Fig. 1 — Time-current curves for thermal relay unit, size 0.4 to 50 amp.

The bare hand is not an accepted substitute for a thermometer, but it can be used as such with advantage at times. A little experience will show that if the hand is laid flat on an iron surface which is at a temperature of 60 deg. C. as long as it takes to count ten, that time is about as long as the average person will care to hold it there. A good rule, when a thermometer is not available, is to hold the hand firmly on the core laminations or windings. If it is possible to keep the hand there while counting ten or more, the temperature may be considered as well within safe limits. With certain types of cast frames it may be impossible to place the hand on the core iron or windings, in which case an allowance of from 10 to 15 deg. may be made for the difference in frame and core temperatures.

No set rules for overload capacity can be given which would apply to all 40-deg. motors of different makes, speeds and ratings. Some standard motors will carry 150 per cent of their rating continuously at 40-deg. rise, while others may just make the guarantee. In general, the following may be considered safe figures for standard motors:

A motor which has a temperature rise of 40 deg. C. at full load should carry from 8 to 10 per cent overload continuously at 50-deg. rise. With a 35-deg. rise or a 5-deg. margin at full load, it should carry 5 per cent overload at 40-deg. rise and 15 per cent overload at 50-deg. rise. With 10-deg. margin at full load, it should carry 15 per cent overload at 40-deg. rise and 30 per cent overload at 50-deg. rise.

It follows, therefore, that if it is desirable to get the maximum safe output from a particular motor, a temperature test should be made under actual normal load and overload conditions.

Thermal cutouts and relays are in common use for the protection of small- and medium-sized induction motors. The thermal cutout breaks the motor circuit directly, while the thermal relay breaks the holding coil circuit of a contactor or circuit breaker. This in turn opens the motor circuit.

There are many different types of thermal overload relays available, but the principle of operation is essentially the same for all. The heating element is generally given the ampere rating at which it will trip the relay when the ambient air temperature is 40 deg. C. Some older types were given the motor ampere rating that they were supposed to be used with and to give protection, but this was rather indefinite and caused trouble. In many types the setting is now fixed, while in others the position of the heating element can be changed in its relation to the fusible alloy, in this way increasing or decreasing the rating.

As the heat developed is practically in proportion to the square of the current flowing, the tripping action has an inverse-time effect, tripping quickly with a large increase in current, and taking a longer time to act with a moderate increase.

Choosing the Correct Relay

When the correct rating is chosen, the thermal relay is one of the best means of protecting motor windings from being damaged by excessive currents. Unfortunately it is impossible to tell exactly from its ampere rating at what current a particular relay will trip when in service. This is dependent chiefly on the air temperature inside the switch box and the thermal characteristics of the heating element.

If the switch is in a warm room the relay may function at a current value close to its rating. In a cool room, or if subject to drafts of cold air from doors or windows, the relay will carry considerably more current than its rating.

A motor may be located in a position where it is subject to air conditions entirely different than those around the switch box. As it is the motor that is to be protected it is sometimes necessary to use a relay which has a lower ampere rating than the actual current at which it is desired to trip.

Variations in tripping time to be expected with thermal relays are indicated by the curves, Fig. 1, which are from tests made on a reliable make. As stated by the manufacturer, the rating given the relay is the current at which it will ultimately trip with an ambient temperature of 40 deg. C. Curve *A* shows that the relay trips in about 10 min. with rated current at 40 deg. and will carry 93 per cent of its rating at 40 deg. without tripping. Curve *B* shows that at 16 deg. C. the relay will carry 108 per cent of its rating and trip at about 111 per cent.

Under average conditions the temperature inside the switch box will probably be from 25 to 30 deg. C. or somewhere between the two curves. Therefore, the relay's rated amperes can be taken as the maximum current it will carry and 106 per cent as the tripping current. As the carrying capacity is increased 16 per cent at 16 deg. C. an increase of one per cent in the ampere rating can be allowed for each 1.5 deg. that the actual air temperature inside the switch box is below 40 deg.

Suppose the air around the motor and switch box is 25 deg. C. and the air inside the switch box 30 deg. C. The motor can be assumed to have a close rating with 40-deg. rise at full load and 50-deg. rise at 110 per cent load. The switch box temperature is assumed to be $40 - 30 = 10$ deg. lower than normal. As previously indicated, the rating of the relay can be increased one per cent for each 1.5 deg. difference between 40 deg. ambient and the actual temperature. In this case the increase is $10 \div 1.5 = 6.6$, so that the actual ampere rating of the relay is approximately 106.6 per cent of its nominal rating. For close protection up to 50-deg. rise, 110 per cent motor rating in amperes equals 106.6 per cent of relay rating. The relay rating equals $110 \times 106.6 \div 100 = 117.2$ per cent of rated motor amperes. This would allow the motor to reach $50 + 25 = 75$ deg. C. before the relay would trip.

Consider the average motor that will carry 15 per cent overload at 50-deg. rise. Under the same room conditions as before, a relay to protect it from overload would be rated $106.6 \times 115 \div 100 = 122.5$ per cent of motor ampere rating, in order to limit the motor's operating temperature to approximately $50 + 25 = 75$ deg.

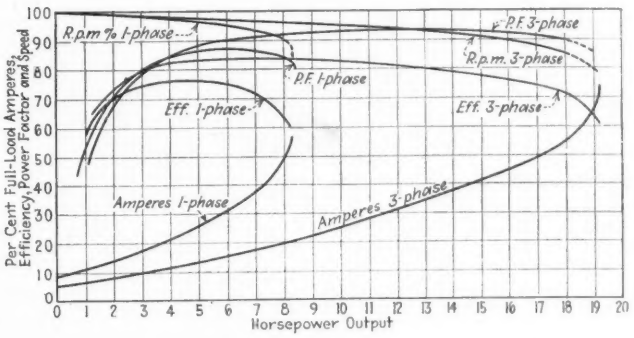


Fig. 2—Comparison between 3-phase and single-phase operation of a 7.5-hp., 60-cycle, 1,800-r.p.m. induction motor

Suppose air temperature inside the switch box is 30 deg. and that of the air around the motor only 20 deg. If the air conditions were known to be stable the allowable temperature rise and overload rating of the motor could be increased. Allowing say 20 per cent overload, the relay rating required to protect the motor would be $106.6 \times 120 \div 100 = 127.9$ per cent of the motor amperes rating. The temperature rise would be approximately 60 deg. and the motor temperature $60 + 20 = 80$ deg.

Assume the motor to be operating in an air temperature of 30 deg., with the switch located where the air around the relay was only 16 deg. The relay would then carry a current $(40 - 16) \div 1.5 = 16$ per cent more than its rating. To protect the motor at 15 per cent overload, a relay would have to be selected with a capacity such that 116 per cent of its rating equalled 115 per cent motor amperes. Such a relay would have a rating equal to $115 \times 100 \div 116 = 99$ per cent of the motor ampere rating. This would allow the motor to operate at $50 + 30 = 80$ deg. C.

It is easily seen that a relay picked at random with a rating of say 125 per cent of the motor amperes would offer no protection against overheating under the conditions just outlined. The relay would carry $125 \times 116 \div 100 = 145$ per cent of the motor ampere rating, allowing approximately 40 per cent overload on the motor and permitting it to reach a dangerous temperature. Some motors would carry this overload without damage, but the average motor would not.

When a three-phase motor having a star-connected winding, Fig. 3, is run single-phase, it will for the same output draw approximately double the three-phase line amperes. For equal efficiency and power factor the ratio between the three-phase and single-phase current would be 1 to 1.732. As the efficiency and power factor is considerably less when running single-phase, the single-phase current will generally be at least double the three-phase value.

With two-thirds of the winding in circuit at double current the stator copper loss would be about 265 per cent of the three-phase loss for the same load. The rotor loss will also increase because of the increased slip and because it has to supply the cross-magnetizing field of the motor.

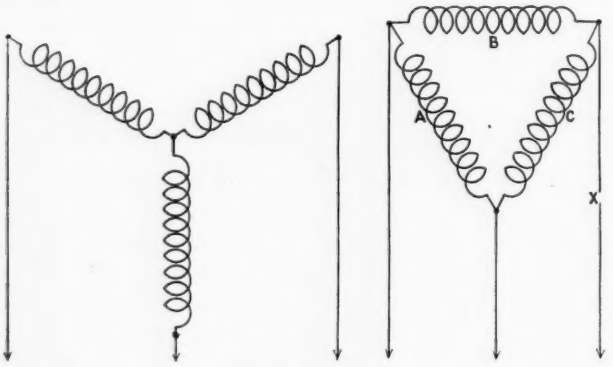


Fig. 3 (Left)—Diagram of a series-star connection
Fig. 4—Diagram of a series-delta connection

The average of several tests showed that for a temperature rise equal to the three-phase full-load value, the single-phase current was 118 per cent and the single-phase output 54 per cent of the respective three-phase figures.

Fig. 2 shows the characteristics of a 7½-hp., 3-phase, 60-cycle, 1,800-r.p.m. squirrel-cage motor run three phase and also single phase. The maximum stable output is 18 hp. for three-phase and 7¼ hp. for single-phase, showing that the motor would stall if the rated load were maintained and one of the three-phase lines opened. This is not unusual, as a three-phase motor which will keep running fully loaded single-phase must have a maximum torque and horsepower above the average.

If the efficiencies and outputs are checked it will be found that at slightly under 5 hp. and 25.8 amp. single-phase and at 7½ hp. and 19.1 amp. three-phase total losses in the motor are equal. Temperature rise, however, is not the same, owing to distribution of the losses.

If stator resistance per phase is assumed to be one ohm, then the three-phase stator copper loss is $19.1^2 \times 3 = 1{,}094.4$ for the whole winding, and the single-phase stator copper loss is $25.8^2 \times 2 = 1{,}331.28$ for two-thirds of the winding. $1{,}331.28 \times 100 \div 1{,}094.4 =$ 122 per cent, an increase of 22 per cent in copper loss. The loss per active phase is increased to $25.8^2 \times 100 \div 19.12^2 = 182.4$ per cent of the three-phase loss, with the result that the windings have a greatly increased temperature rise.

With this motor, the temperature rise is approximately the same when operating single-phase at 4.2 hp. and 21.5 amp. as at 7½ hp., 19.1 amp. three-phase, or with 56 per cent of the three-phase load and 113 per cent of the three-phase current. The copper loss per active phase for a star-connected winding is the same for equal line currents whether running three-phase or single-phase, so that overload protection which will prevent overheating as a three-phase motor will also give single-phase overload protection.

Delta-Connected Motors

The distribution of the losses in a delta-connected three-phase motor when running with one line opened, as at *X*, Fig. 4, is different from that of the star-connected motor, but the motor will act practically the same as when star-connected. For equal output the line current will be more than double the three-phase value, dividing up between the two circuits approximately in the ratio 2 to 1. Group *A*, or the short path, will take two-thirds of the total current.

Assume that the single-phase load is such as to make the line current the same as the normal full-load value, say 30 amp., and let the phase resistance be one ohm. The line current splits up into two circuits, 20 amp. going through winding *A* and 10 amp. through groups *B* and *C*. Under three-phase conditions the current in each phase group would be $\frac{30}{\sqrt{3}} = 17.32$ amp. The total copper loss for three-phase operation would be $17.32^2 \times 3 = 900$ and the single-phase losses $(20^2 \times 1) + (10^2 \times 2) = 600$. It will be noted that for equal line currents the single-phase total loss is two-thirds of the three-phase loss, the same as with a star-connected motor, but in this case the loss in group *A* is $20^2 \times 1 = 400$, or an increase of 33 per cent for this part of the winding.

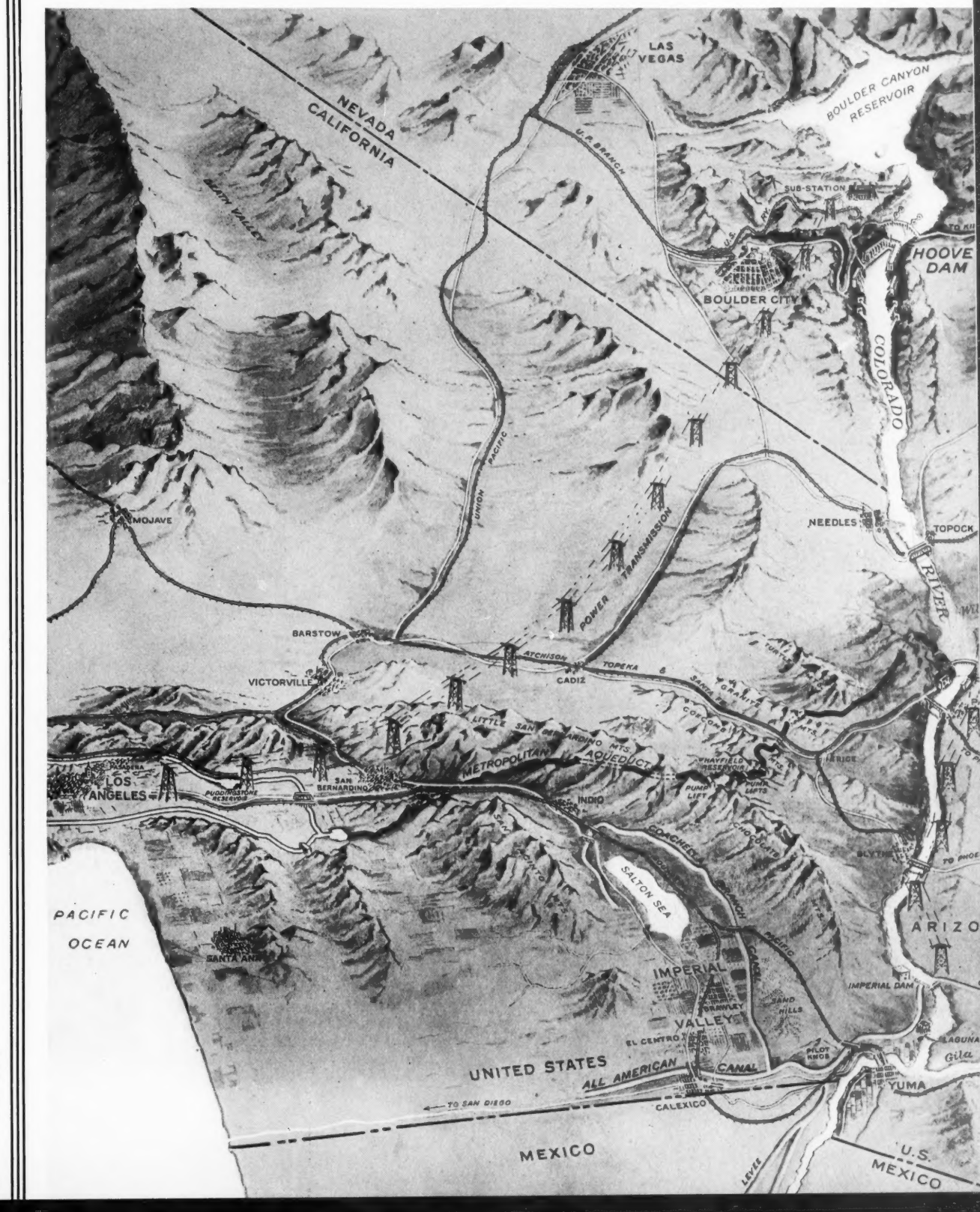
It is apparent that for equal line currents a delta-connected, three-phase motor running single-phase with one line open would have one-third of the winding carrying, approximately 15.5 per cent more current than it would take when operating three phase. This concentration of two-thirds of the stator copper loss into one-third of the winding causes local heating and reduces the safe current and horsepower capacity of the motor below that of a star-connected motor. For this reason the overload relay to protect a delta-connected motor against single-phasing should trip at a lower current value than that used to protect a star-connected motor of the same horsepower rating. The tripping current should be as close to the three-phase full-load amperes as it is practical to use under the load condition.

Due to the effects of the distribution of the winding in the slots, circulating current may be set up in the windings of a delta-connected motor when running single-phase if conditions are favorable. With certain combinations of parallel groupings combined with unequal air-gap clearances, trouble may be expected. However, if the motor is protected as previously outlined, the windings will be in no danger of burning out.

Commercial three-phase services are not ideal by any means; line voltages are generally somewhat unbalanced and in some cases not in exact phase relation with each other. This often causes trouble in the ordinary operation of three-phase motors, particularly with those having parallel-stars, or delta-connected windings. The motor acts as a phase converter tending to correct the line conditions; this results in circulating currents being set up with consequent overheating of the motor. In several instances three-phase motors have been known to get dangerously hot from this cause, even when running well under their rated load.

1,835,000 HP.

•HOOVER DAM project, now under construction to tap 1,835,000 hp. from the Colorado River, is at the upper right in this panoramic perspective. The dam will be 735 ft. high, the highest in the world, and will form a storage reservoir of 30,500,000 acre-feet capacity. Just below the dam is the power house, on both sides of the river, designed to contain fifteen 115,000-hp. and two 55,000-hp. units. Parker Dam (right center) will be built by the Metropolitan Water District of Southern California. From this dam an aqueduct 250 miles long will carry a billion gallons of water a day to Los Angeles and adjacent cities. The water will be pumped over the mountains against a total head of 1,603 ft. and will require nearly 400,000 hp. of pumps, located in five plants, the largest plant requiring about 100,000 horsepower.

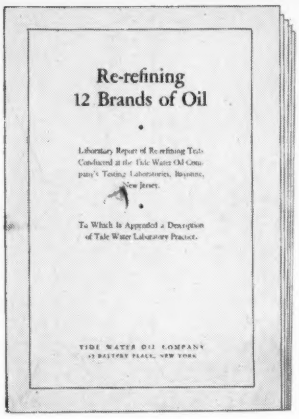


Construction activities and area adjacent to Hoover Dam, from a Bureau of Reclamation study.

ANOTHER POWER PLANT

Startling Facts Prove

Electrical Testing Laboratories, N. Y., observer (left) witnessing the RE-*refining test described in this announcement. The data is certified by the E. T. L. Others in photo (left to right), Tide Water research chemist, Tide Water technologist, and representative of power plant operator.*


Re-refining
12 Brands of Oil
To Which Is Appended a Description
of Tide Water Laboratory Practice.
TIDE WATER OIL COMPANY

★ *Tide Water bought in the open market 12 leading brands of competitive turbine and Diesel oils. These oils were* RE-*refined by Tide Water's Edeleanu Process. Complete data is contained in Laboratory Report, "*RE-*refining 12 Brands of Oils." Copy upon request.*

OPERATOR GETS PROOF

Superiority of TYCOL

Electrical Testing Laboratories of New York witness and certify RE-*refining test*

The latest test in our campaign to have you "Know Your Oils" is nothing short of startling! Even the now famous 12 brands test★ (see foot note, opposite page) falls short of this latter one.

Realize that we had publicly offered to have any power plant operator bring us an unused sample of any competitive turbine or Diesel oil. We had offered to re-refine that oil, in his presence, by Tide Water's Edeleanu Process, and to take out the impurities that only Tide Water's exclusive process can remove.

But this time we went a step further: we had the tests witnessed and certified by an impartial technologist from the Electrical Testing Laboratories, N. Y.

AMAZING PERCENTAGE OF IMPURITIES REMOVED

The oil tested was a standard nationally-known Diesel lubricating oil. It was brought to us by an important Maryland power plant operator, who asked us to prove our case. The tests showed:

1. The original oil came from low-grade crude, as indicated by gravity, temperature-viscosity curve, oxidation number.
2. Tide Water's Edeleanu Process rejected 23.5% that the original refining left in the oil.
3. The rejected 23.5% was unstable extract unfit for Diesel service. (Specific gravity was that of heavy fuel oil; consistency, that of liquid asphalt; oxidation number, dangerously high).
4. The purified oil was greatly improved in stability, as shown by a 59% decrease in oxidation number from that of the original oil. (See chart below).

PROOF PILED UPON PROOF

Here is definite proof that Tycol Turbine and Diesel Oils . . . being 100% paraffine base, and refined by this exclusive process . . . have a purity and stability that no other oils possess. And the reason is easily understood. The process is physical . . . not chemical. It physically dissolves and extracts ALL unstable hydrocarbons. It avoids all the chemical reactions of conventional refining, reactions that attack and impair the pure and desirable hydrocarbons, while endeavoring to remove the impure ones.

And in service, too, Tycol Oils are piling proof upon proof. Based on service records . . . made for some of the country's leading producers of power . . . you can depend on Tycol Oils for low acidity, low carbon deposition and better demulsibility. You can depend on them for stability, for non-sludging, long-lasting, efficient, economical lubrication. Tide Water Oil Sales Corp., 17 Battery Place, New York.

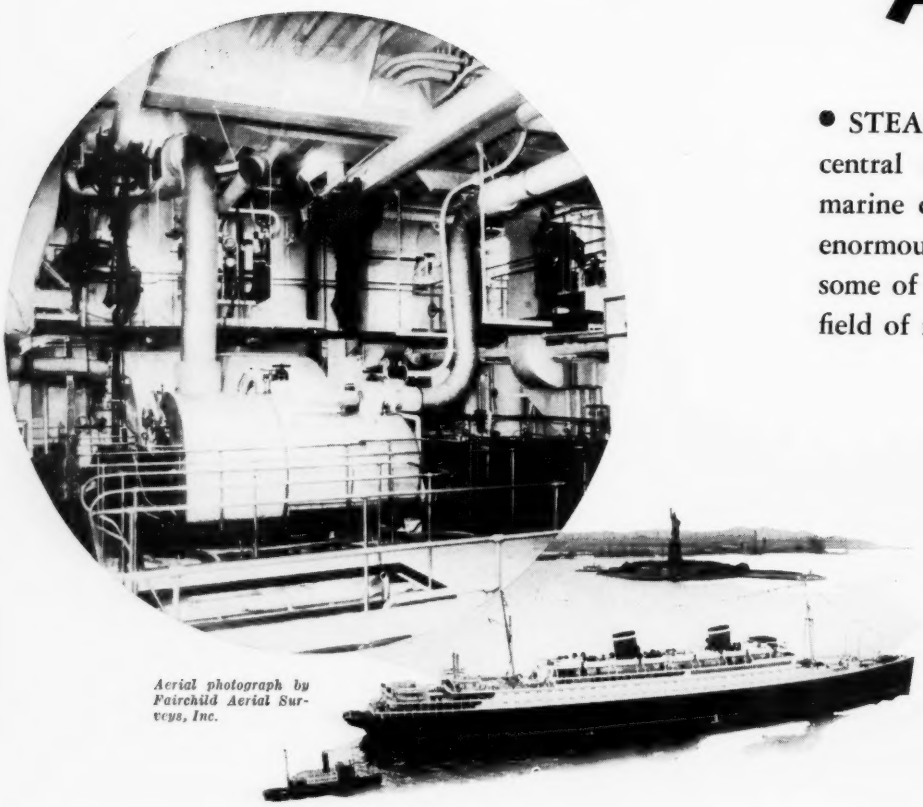
DATA FROM RE-REFINING TEST BAYONNE, N. J., NOV. 9, 1932

TESTS	SUBMITTED SAMPLE ORIGINAL OIL	PURIFIED OIL 76.5%	UNSTABLE EXTRACT 23.5%
Gravity	19.2	22.9	8.9
Viscosity @ 100° F	539	445	1823
Viscosity @ 210° F	55	54	63
Color ASTM	2½	2	6½
Oxidation Number (Average of two tests)	271	113	403

INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER

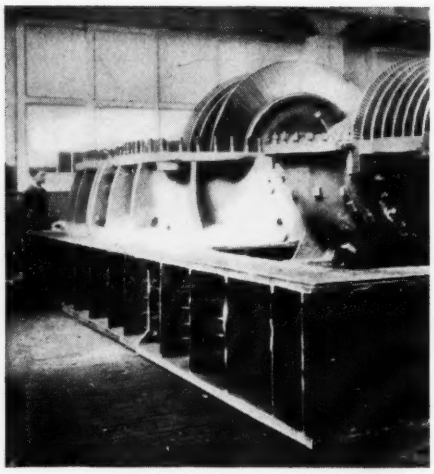
More POWER for the ATLANTIC



Aerial photograph by Fairchild Aerial Surveys, Inc.

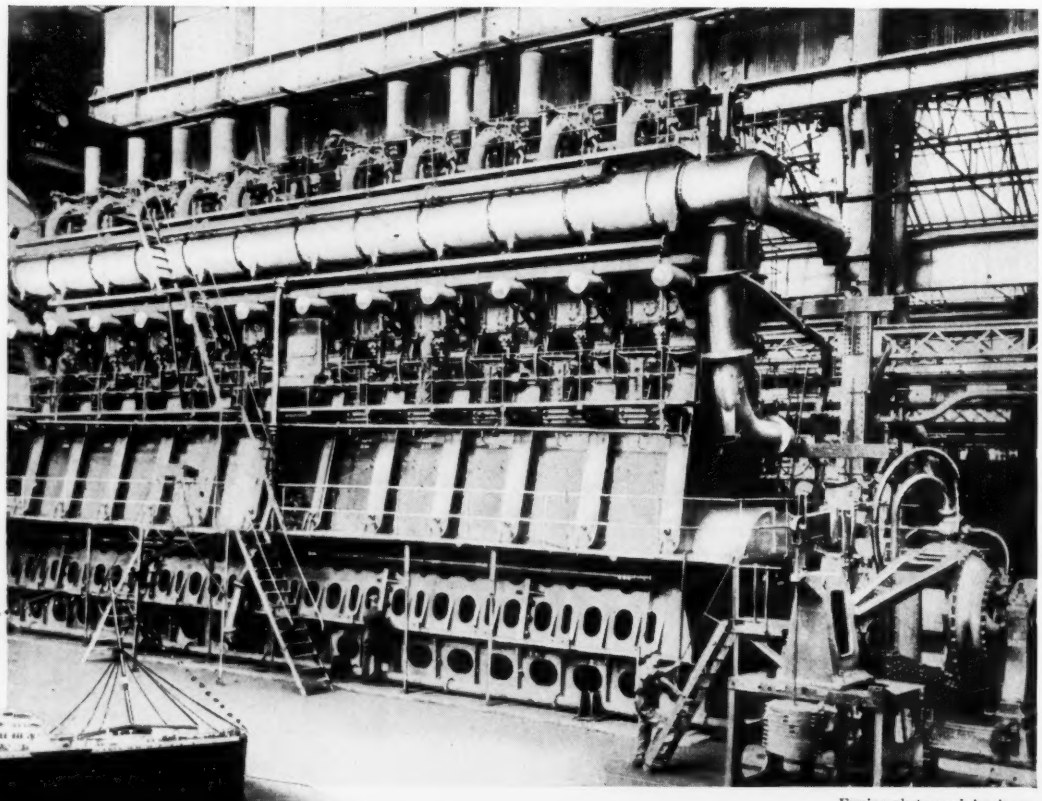
• STEAM PLANTS equivalent to large central stations, largest and lightest marine diesels, motors of 40,000 s.hp., enormous stabilizing power—these are some of the recent achievements in the field of marine power. Here are illus-

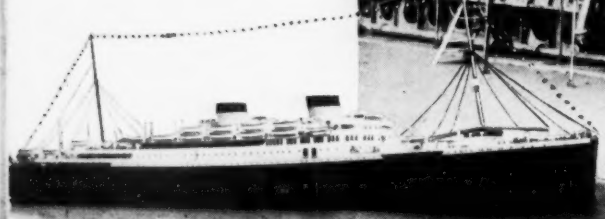
• NORMAL OUTPUT of 30,000 s.hp. is produced by two 3-cyl., cross-compound, impulse-reaction turbines of the *S.S. Manhattan.* The units (starboard illustrated) rotate at 1,500 r.p.m.



• ONE OF four 2,430-r.p.m. 34,200-kw. main turbines for the world's largest ship, the *Normandie.*

• LARGEST marine diesels are the two 10,000-hp. units of the *M. V. Georgic.* They are 10-cyl., double-acting, 4-cycle, Harland-B.&W. air-injection units with separate diesel-driven air compressors. Exhaust heat is utilized in the largest waste heat boilers afloat

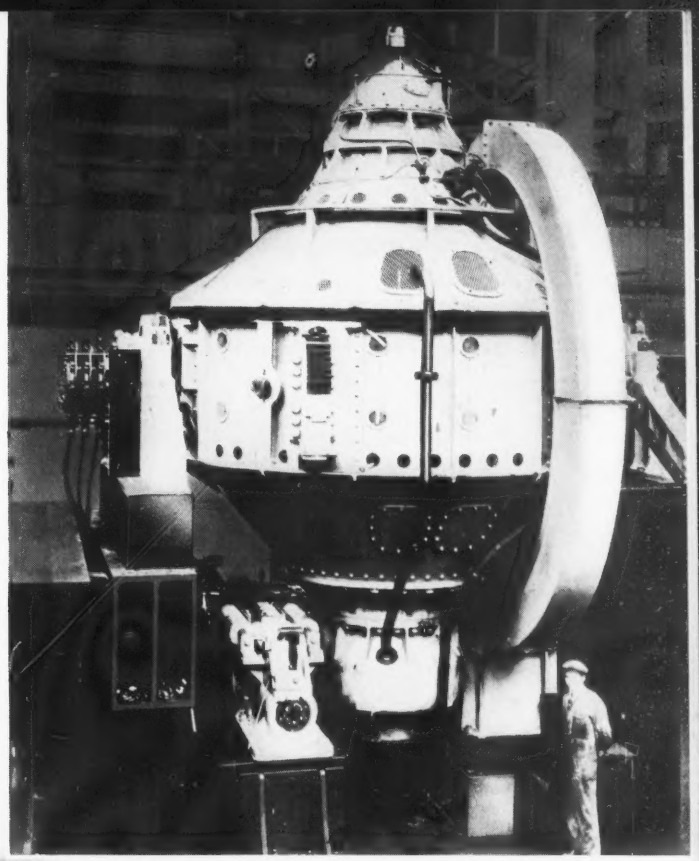


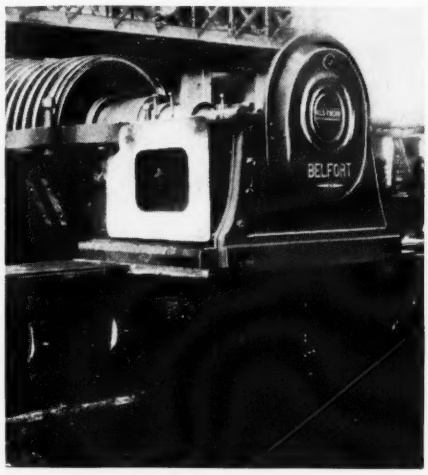


Engine photograph by Acme

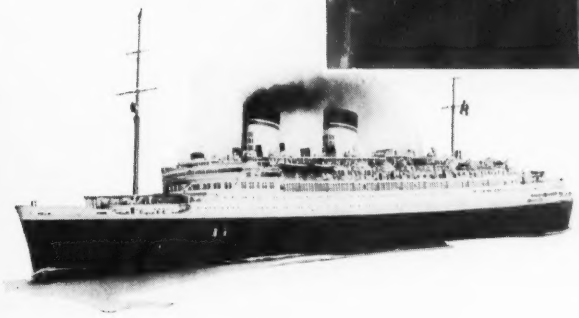
HIGHWAY

trated and described the power plant of the largest American-built ship, the *Manhattan,* and those of some of her foreign contemporaries, including the *Georgic, Conte di Savoia, Normandie,* and a diesel like those of the *Bremse*

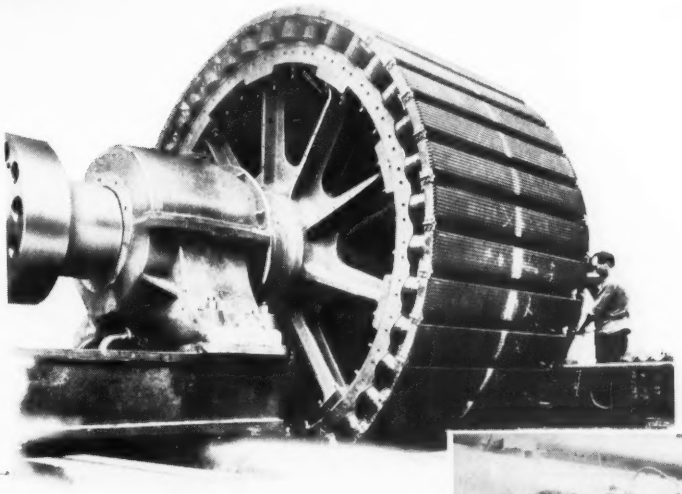




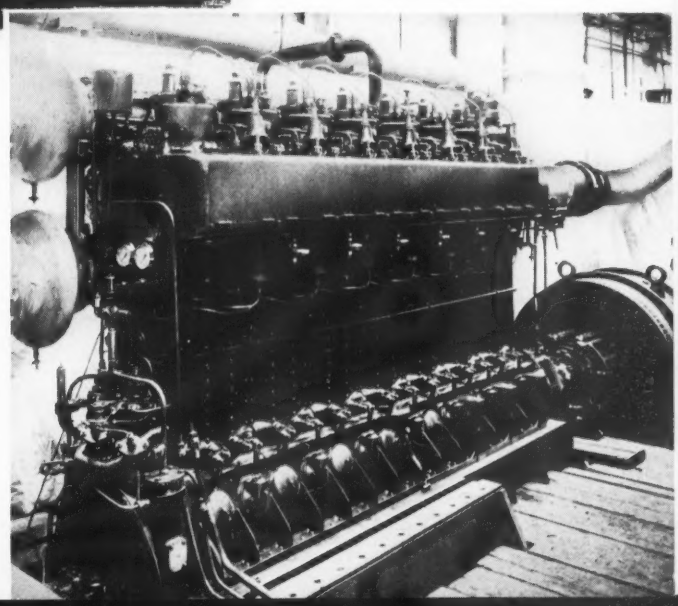
Steam is supplied at 400 lb. and 662 deg. F. Six auxiliary turbines will produce 2,200 kw. apiece



● THREE Sperry gyro-stabilizers hold the *Conte di Savoia* steady. Their 110-ton rotors are 13 ft. in diameter and run at 910 r.p.m. max. to develop a torque of 7,860 foot-tons, although spinning motors are only 390 hp. (560 max.) each and precession motors 100 hp. (200 max.)

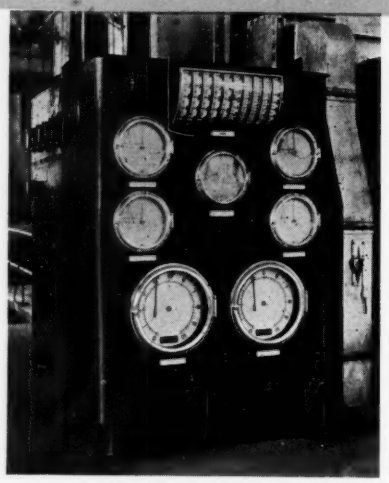


● ROTOR of the world's largest motor, a 40,000-s.hp. unit and one of the four to be installed in the *Normandie* to make her the highest-powered passenger ship



● A 7-CYL., 11.8x17.3-in., M.A.N. diesel being tested by U. S. Navy for submarines. It develops 2,300 hp. at 560 r.p.m. and 2,500 hp. at 600 r.p.m. and weighs only 10.6 lb. per hp.

COCHRANE
FLOW METER



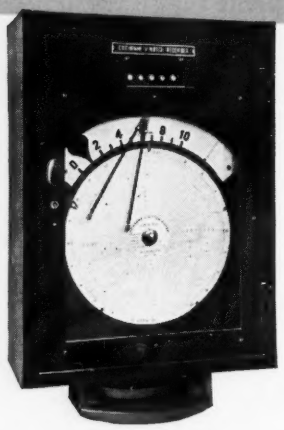
Winning out on performance

"OUR selection was made after a very thorough and comprehensive survey of the various boiler recording instruments on the market, together with the recommendations of outstanding consulting engineers" — writes the State Architect of a Western State, which now uses 28 Cochrane Steam Flow Meters, adding "Our engineers have expressed very favorable comments on the equipment and I feel justified in recommending it for any plant where accuracy is desired."

Similarly, a Cochrane representative on the other side of the World writes of 34 Cochrane Flow Meters installed by him: "From the whole lot, up to date, we have not received a single complaint and in every case our users are more than satisfied."

Every Cochrane Flow Meter is guaranteed as to accuracy and mechanical perfection and is provided with a test weight by means of which the accuracy can easily and quickly be checked at any time.

COCHRANE
V-NOTCH METER



Accurate at all rates of flow

The V-notch meter is superior for many purposes because of its simplicity, accessibility and accuracy, particularly at small fractional flows, where a pipe flow meter would be quite undependable.

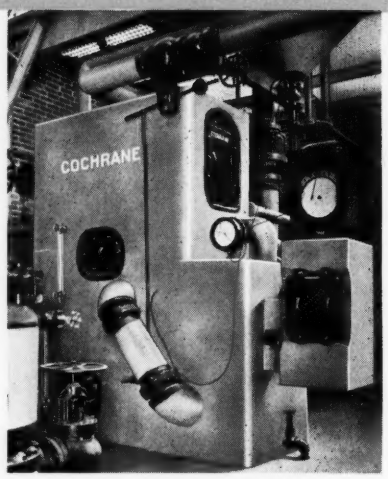
THE COCHRANE V-NOTCH RECORDER stands alone in using a simple, direct drive from the float measuring the head on the weir to the pointer, recording pen and integrator. It is not thrown out of adjustment by rapid fluctuations in water level nor by flashing due to quick reduction in pressure on hot water.

Cochrane Independent V-notch Meters and Metering Heaters make accurate cost accounting possible in the boiler room and factory by measuring boiler feed, condensed returns, make up, in fact any liquid that will flow over a weir. There is the equivalent of more than a million horse power of Cochrane V-notch meters and metering heaters in present satisfactory service.

Accuracy is guaranteed to be within 1½ per cent of actual weight.

Ask for Cochrane Bulletin L-679-A

COCHRANE
METERING DEAERATING HEATER



Total feed water heated, deaerated and metered

THE steam plant of the Indianapolis City Hospital has been fully equipped with control instruments to facilitate efficient operation.

The boiler feed water is brought to the full temperature of the exhaust steam, made non-corrosive by driving off dissolved oxygen and accurately measured, recorded and totalized by a Cochrane Metering Deaerating Heater, while the steam delivered from each of the three boilers is measured, recorded and totalized by a Cochrane Pipe Flow Meter.

The engineer in charge thus has a continuous record of plant operation, from which he can calculate boiler room performance under all conditions of operation.

COCHRANE CORPORATION, 17th & Clearfield Streets, PHILADELPHIA, PA.

THE HIGH TORQUE FLOW METER

THE Cochrane Flow Meter is outstanding by reason of the high torque or turning moment developed by its tilting manometer and available for moving the recording pen and integrator. The high ratio of available power to friction makes possible:

1. Close guaranteed accuracy,
2. Simple, serviceable and rugged construction,
3. Years of durability under adverse conditions,
4. Easy maintenance by unskilled men,
5. Accurate and reliable integration.

The first Cochrane Flow Meter, placed in service 10 years ago, is still working.

In ordering 10 additional meters, the user of a meter installed 4 years ago states that it has never failed to produce its daily chart.

Four years ago a prominent university ran a competitive test on flow meters. The Cochrane proved most accurate and 5 were ordered. A year later 8 more were purchased and last year 2 more. Another university recently selected the Cochrane Flow Meter after competitive tests.

Cochrane Meter sales are growing rapidly and the great majority are on repeat orders. Some of the reasons for this popularity are given above. For others, read our new Bulletin L-690

M-23

COCHRANE CORPORATION, 17th & Clearfield Streets, PHILADELPHIA, PA.

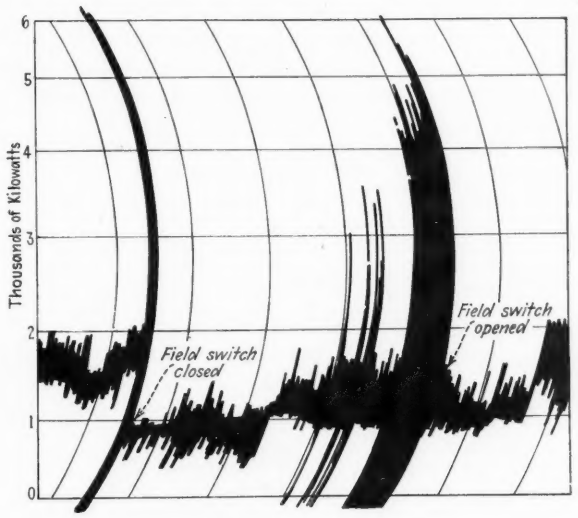
POWER'S DATA SHEETS — NUMBER 7

COMMERCIAL COPPER WIRES

PROPERTIES, NATIONAL ELECTRICAL CODE RATINGS AND REQUIRED CONDUIT SIZES

B. & S. Gage No.	Area in Circular Mils = (Diam. in Mils)²	Diameter in Mils = √Circ. Mils (Solid)	Resistance, Ohms at 68 Deg. F.		Weight Bare, Lb.		Typical Cable Stranding			Required Size of Conduit, Two-Wire and Three-Wire Systems									Distance Between Supports in Vertical Risers, Ft.	Rubber Insulation (A)						Varnished-Cloth Insulation (B)						Other Insulation (C)		Circ. Mils or B. & S. Gage No.
							Strands			No. of Conductors in One Conduit										Allowable Carrying Capacity, Amperes	Volts Drop per 1,000 Ft. at Rated Current	600 Volts				Allowable Carrying Capacity, Amperes	Volts Drop per 1,000 Ft. at Rated Current	600 Volts				Allowable Carrying Capacity, Amperes	Volts Drop per 1,000 Ft. at Rated Current	
																						One Braid		Two Braids					One Braid		Two Braids				
			Per 1,000 Ft.	Per Mile	Per 1,000 Ft.	Per Mile	No. of Strands	Diam. in Mils.	Outside Diam., Bare, In.	1	2	3	4	5	6	7	8	9				Approx. Over-all Diam., In.	Approx. Weight per 1,000 Ft., Stranded Insulated Lb.	Approx. Over-all Diam., In.	Approx. Weight per 1,000 Ft., Stranded, Insulated, Lb.				Approx. Over-all Diam., In.	Approx. Weight per 1,000 Ft., Stranded Insulated, Lb.	Approx. Over-all Diam. In.	Approx. Weight per 1,000 Ft., Stranded, Insulated, Lb.			
										Minimum Size of Conduit, Elec. Trade, Size, In.																										
....	2,000,000	1,414	0.0052	0.0274	6,100	32,200	127	125.5	1.632	3	5	6	....	....	....	....	....	....	35	1,050	5.5	1.95	6,725	1.995	7,096	1,260	6.6	1.95	6,651	1.995	6,731	1,670	8.7	2,000,000
....	1,900,000	1,378	0.0055	0.0290	5,796	30,600	127	122.3	1.590	3	5	6	....	....	....	....	....	....	35	1,010	5.6	1.91	6,414	1.952	6,760	1,210	6.7	1.91	6,326	1.952	6,404	1,610	8.9	1,900,000
....	1,800,000	1,342	0.0058	0.0306	5,490	29,000	127	119.1	1.548	3	5	6	6	....	....	....	....	....	35	970	5.6	1.87	6,103	1.908	6,424	1,160	6.7	1.87	6,000	1.909	6,076	1,550	9.0	1,800,000
....	1,700,000	1,304	0.0062	0.0327	5,186	27,400	91	136.7	1.504	3	5	5	6	....	....	....	....	....	35	930	5.8	1.83	5,792	1.864	6,088	1,120	6.9	1.83	5,674	1.864	5,749	1,490	9.2	1,700,000
....	1,600,000	1,265	0.0065	0.0343	4,880	25,800	91	132.6	1.459	2½	5	5	6	....	....	....	....	....	35	890	5.8	1.79	5,481	1.820	5,752	1,070	7.0	1.80	5,348	1.820	5,421	1,430	9.3	1,600,000
....	1,500,000	1,225	0.0070	0.0369	4,576	24,200	91	128.4	1.412	2½	4½	5	6	....	....	....	....	....	35	850	6.0	1.74	5,170	1.776	5,416	1,020	7.1	1.74	5,022	1.776	5,093	1,360	9.5	1,500,000
....	1,400,000	1,183	0.0075	0.0396	4,270	22,500	91	124.0	1.364	2½	4½	5	6	....	....	....	....	....	35	810	6.1	1.68	4,832	1.716	5,065	970	7.3	1.60	4,697	1.716	4,761	1,290	9.7	1,400,000
....	1,300,000	1,140	0.0084	0.0443	3,963	20,900	91	119.5	1.315	2½	4½	5	6	6	....	....	....	....	35	770	6.5	1.62	4,498	1.656	4,714	920	7.7	1.62	4,372	1.656	4,431	1,220	10.2	1,300,000
....	1,200,000	1,095	0.0088	0.0464	3,660	19,300	91	114.8	1.263	2½	4½	4½	6	6	....	....	....	....	35	730	6.4	1.56	4,164	1.596	4,363	880	7.7	1.56	4,047	1.596	4,100	1,150	10.1	1,200,000
....	1,100,000	1,048	0.0095	0.0501	3,356	17,700	91	109.9	1.209	2½	4	4½	6	6	....	....	....	....	35	690	6.6	1.50	3,834	1.536	4,012	830	7.9	1.50	3,722	1.536	3,769	1,080	10.3	1,100,000
....	1,000,000	1,000	0.0105	0.0555	3,050	16,100	61	128.0	1.152	2	4	4	5	6	6	....	....	....	35	650	6.8	1.44	3,500	1.476	3,661	780	8.2	1.44	3,397	1.476	3,438	1,000	10.5	1,000,000
....	950,000	974.7	0.0111	0.0586	2,898	15,300	61	124.8	1.122	2	4	4	5	6	6	6	....	....	35	625	6.9	1.41	3,312	1.447	3,495	750	8.3	1.41	3,220	1.447	3,269	960	10.7	950,000
....	900,000	948.7	0.0117	0.0617	2,745	14,500	61	121.5	1.093	2	3½	4	4½	5	6	6	....	....	35	600	7.0	1.38	3,125	1.417	3,321	720	8.4	1.38	3,043	1.417	3,101	920	10.8	900,000
....	850,000	922.0	0.0124	0.0655	2,593	13,700	61	118.0	1.062	2	3½	4	4½	5	6	6	....	....	35	575	7.1	1.35	2,972	1.386	3,150	690	8.6	1.35	2,880	1.386	2,940	880	10.9	850,000
....	800,000	894.4	0.0131	0.0691	2,440	12,900	61	114.5	1.031	2	3½	4	4½	5	6	6	6	....	35	550	7.2	1.32	2,810	1.354	2,982	660	8.6	1.32	2,723	1.354	2,778	840	11.0	800,000
....	750,000	866.0	0.0140	0.0739	2,288	12,100	61	110.9	0.997	2	3½	3½	4½	5	6	6	6	....	40	525	7.4	1.30	2,645	1.322	2,809	630	8.8	1.30	2,567	1.322	2,615	800	11.2	750,000
....	700,000	836.7	0.0150	0.0792	2,135	11,300	61	107.1	0.964	2	3½	3½	4½	5	5	6	6	....	40	500	7.5	1.25	2,490	1.288	2,634	600	9.0	1.25	2,400	1.288	2,452	760	11.4	700,000
....	650,000	806.2	0.0168	0.0886	1,983	10,500	61	103.2	0 929	2	3½	3½	4	4½	5	6	6	6	40	475	8.0	1.22	2,330	1.253	2,469	570	9.6	1.22	2,250	1.253	2,288	720	12.1	650,000
....	600,000	774.6	0.0175	0.0923	1,830	9,660	61	99.2	0.892	2	3	3½	4	4½	5	6	6	6	40	450	7.9	1.18	2,170	1.216	2,296	540	9.5	1.18	2,096	1.216	2,125	680	11.9	600,000
....	550,000	741.6	0.0191	0.101	1,678	8,860	61	95.0	0.854	1½	3	3½	4	4½	5	5	6	6	40	425	8.1	1.14	1,992	1.179	2,120	510	9.7	1.14	1,905	1.179	1,947	640	12.2	550,000
....	500,000	707.1	0.0210	0.111	1,525	8,050	37	116.2	0.814	1½	3	3	3½	4	4½	5	5	6	50	400	8.4	1.08	1,815	1.107	1,914	480	10.1	1 08	1,725	1.107	1,770	600	12.6	500,000
....	450,000	670.8	0.0234	0.124	1,373	7,250	37	110.3	0.772	1½	3	3	3½	4	4½	4½	5	6	50	365	8.5	1.04	1,645	1.065	1,734	435	10.2	1.04	1,563	1.065	1,607	550	12.9	450,000
....	400,000	632.5	0.0263	0.139	1,220	6,440	37	103.9	0.727	1¼	3	3	3½	4	4	4½	5	5	50	325	8.5	1.00	1,470	1.021	1,564	390	10.3	1.00	1,400	1.021	1,442	500	13.2	400,000
....	350,000	591.6	0.0300	0.158	1,068	5,640	37	97.2	0.680	1¼	2½	3	3½	3½	4	4½	4½	5	60	300	9.0	0.94	1,290	0.974	1,385	360	10.8	0.94	1,233	0.974	1,273	450	13.5	350,000
....	300,000	547.7	0.0350	0.185	915	4,830	37	90.0	0.630	1¼	2½	3	3	3½	3½	4	4½	4½	60	275	9.6	0.90	1,135	0.923	1,210	330	11.6	0.90	1,070	0.923	1,108	400	14.0	300,000
....	250,000	500.0	0.0420	0.222	762	4,020	37	82.1	0.575	1¼	2½	2½	3	3	3½	3½	4	4½	60	250	10.5	0.83	965	0.868	1,032	300	12.6	0.83	905	0.868	941	350	14.7	250,000
0000	211,600	460.0	0.0497	0.262	645	3,400	19	105.5	0.528	1¼	2	2½	2½	3	3	3½	3½	4	80	225	11.2	0.75	800	0.779	859	270	13.4	0.75	758	0.779	790	325	16.2	0000 B.&S.
000	167,800	409.6	0.0625	0.330	513	2,710	19	94.1	0.471	1	2	2	2½	3	3	3	3½	3½	80	175	10.9	0.70	650	0.721	702	210	13.1	0.70	612	0.721	641	275	17.2	000
00	133,100	364.8	0.0789	0.416	406	2,140	19	83.7	0.419	1	2	2	2½	2½	3	3	3	3½	80	150	11.8	0.64	530	0.670	577	180	14.2	0.64	497	0.670	524	225	17.8	00
0	105,500	324.9	0.0995	0.525	322	1,700	19	74.6	0.373	1	1½	2	2	2½	2½	3	3	3	100	125	12.4	0.60	435	0.624	475	150	14.9	0.60	405	0.624	431	200	19.9	0
1	83,690	289.3	0.1258	0.663	255	1,346	19	66.3	0.332	¾	1½	1½	2	2	2½	2½	3	3	100	100	12.6	0.56	350	0.583	394	120	15.1	0.56	331	0.583	355	150	18.9	1
2	66,370	257.6	0.1579	0.833	203	1,072	7	97.5	0.293	¾	1¼	1½	1½	2	2	2½	2½	2½	100	90	14.2	0.48	280	0.512	309	110	17.4	0.48	259	0.512	280	125	19.7	2
3	52,630	229.4	0.2004	1.059	160	845	7	86.6	0.260	¾	1¼	1¼	1½	2	2	2	2½	2½	100	80	16.0	0.45	235	0.480	256	95	19.0	0.45	212	0.480	232	100	20.0	3
4	41,740	204.3	0.2525	1.333	127	671	7	77.1	0.231	¾	1¼	1¼	1½	2	2	2	2	2½	100	70	17.7	0.42	195	0.452	214	85	21.5	0.42	170	0.452	189	90	22.7	4
5	33,100	181.9	0.3130	1.653	100	528	7	68.8	0.206	¾	1¼	1¼	1¼	1½	2	2	2	2	100	55	17.2	0.38	165	0.445	182	65	20.3	0.30	141	0.445	159	80	25.0	5
6	26,250	162.0	0.394	2.080	79.46	419.5	7	61.2	0.184	½	1	1¼	1¼	1½	1½	2	2	2	100	50	19.7	0.36	130	0.423	154	60	23.6	0.36	117	0.423	134	70	27.6	6
8	16,510	128.5	0.641	3.388	49.98	263.9	7	48.4	0.145	½	¾	1	1	1	1¼	1¼	1¼	1¼	100	35	22.4	0.29	80	0.330	95	40	25.6	0.29	75	0.330	83	50	32.0	8
10	10,380	101.9	1.010	5.333	31.43	166.0	7	38.6	0.116	½	¾	¾	1	1	1	1¼	1¼	1¼	100	25	25.3	0.26	56	0.299	70	30	30.3	0.26	52	0.299	60	35	35.6	10
12	6,530	80.8	1.601	8.453	19.77	104.4	7	30.6	0.092	½	½	¾	¾	¾	1	1	1	1¼	100	20	32.0	0.24	45	0.275	49	25	40.0	0.24	43	0.275	47	30	48.0	12
14	4,107	64.1	2.565	13.54	12.43	65.6	7	24.2	0.073	½	½	½	¾	¾	1	1	1	1	100	15	38.5	0.22	31	0.256	38	18	46.2	0.22	29	0.256	34	20	51.3	14
16	2,583	50.8	4.040	21.33	7.82	41.3	7	19.3	0.058	....	....	....	....	....	....	....	....	....	....	6	....	....	....	....	....	....	....	....	....	....	....	....	10	.....	16
18	1,624	40.3	6.567	34.67	4.92	26.0	7	15.1	0.045	....	....	....	....	....	....	....	....	....	....	3	....	....	....	....	....	....	....	....	....	....	....	....	6	.....	18

PRACTICAL AIDS TO OPERATION



Synchronous Motor Operates with Field Switch Open

THE CHART shows the power input to a synchronous motor before and after it lost field excitation and when field was again applied. This chart verifies the statements made in an article on page 149 of the September number of *Power*. The chart was taken by a graphic wattmeter in the main line feeding a substation, in which there was operating a bank of 2,200- to 440-volt transformers and two motor-generator sets. No. 2 motor-generator consists of a 1,400-hp., 2,150-volt, 0.8-power factor synchronous motor driving a 1,000-kw., 250-volt direct-current generator.

The trouble occurred on a Sunday, when the mills were shut down to do the weekly maintenance work. For this reason the substation's load was such that it could be carried by one motor-generator set. When shutting down No. 1 motor-generator, the operator made a mistake and opened the field switch of No. 2 instead of that of No. 1 machine. As shown by the chart, No. 2 motor immediately fell out of synchronism and began to hunt. Evidently, the load decreased, for, as can be seen, it soon stopped swinging. During the time the motor was running as an induction motor it growled occasionally and the generator was sluggish in raising its voltage. The motor's inverse time-limit overcurrent relays did not operate to trip the running oil circuit breaker. Even though they were set for 275 per cent of full-load current, the high load swings did not last long enough to complete the closing stroke of the relays.

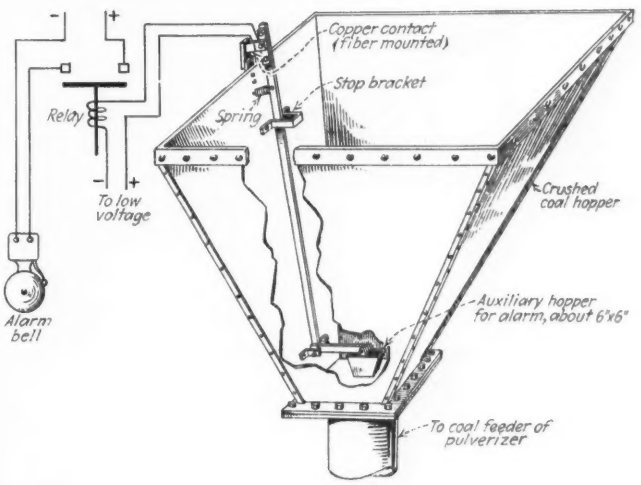
The motor operated with its field open for about one hour, when the foreman on his periodical visit to the station discovered the trouble and closed the field switch on No. 2 motor. As the chart shows, the motor again began to hunt, probably due to load increasing on the generator as the speed of the motor increased to synchronism. Finally, a stable condition was reached and the motor began to operate normally. Inspection showed no damage to the stator, squirrel-cage winding or to the field-discharge resistor. No damage was done to the motor because of the light load carried at the time.

Hammond, Ind. S. EIN.

No-Coal Alarm for Pulverizer-Coal Feeder

A PROBLEM in pulverized-coal, unit-fired boiler plants, which if neglected may cause serious operating difficulties, is that of a continuous flow of coal from the bunkers. If the flow of coal is interrupted due to sticking in the feed pipes, coal scale failing to trip or insufficient supply of coal in bunkers, considerable trouble may be experienced unless the operator notices the fault at once. By providing a no-coal alarm as was done in one plant, warning will be given even before the burners go out.

In the diagram the hopper of a unit coal pulverizer is shown with the necessary attachments for the alarm.



All parts are easily made and assembled, the only purchased parts being a low-voltage relay and bell. Two pieces of strap iron are welded together as shown and form the lever arm, which is supported in two bearings. A small hopper is constructed from sheet steel. It has no bottom, and is suspended from the end of the lever arm.

As long as the coal is above the auxiliary hopper or flowing through it, the lever arm will be held on the stop bracket and against the tension of the spring. If for any reason the coal supply fails the spring will pull the lever back as soon as the auxiliary hopper empties and close the circuit through the relay and bell alarm. H. M. SPRING.

Milford, N. J.

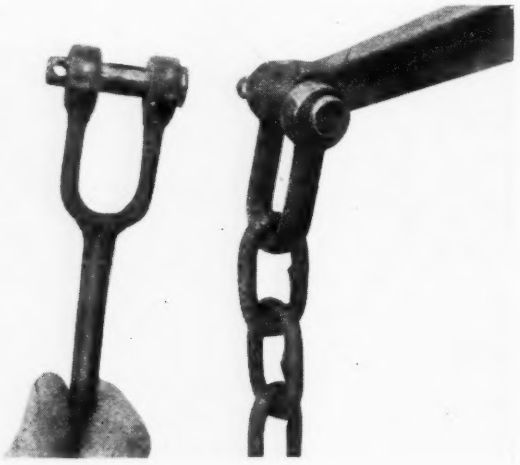
Changes Two Motors and Saves $2,400 Per Year

WE HAVE in our plant 120 squirrel-cage induction motors operating at various speeds and in sizes ranging from 1 to 50 hp. As a result of some of the motors being lightly loaded the plant-load power factor was low. In an effort to improve the power factor operating conditions and reduce the power costs it was decided to improve the loading on some of the motors.

A 50-hp., 900-r.p.m. motor driving a line shaft was found to be loaded only to about 18 hp. and was replaced by one rated at 20 hp. and 1,200 r.p.m. that was available as a spare. Another 50-hp., 1,800-r.p.m. motor driving a blower was replaced by four 3-hp. and one 5-hp., 3,600-r.p.m. motors, all driving blowers, that were purchased second-hand. After the changes were made the power bill dropped about $200 per month. Of this saving about $80 was a reduction in demand and $120 in kilowatt-hour charges. The total cost for making the change was $545, consequently the saving in power costs will pay for replacing the motors in about three months, besides plant operation has been improved. This is another illustration of how a little study of the power-factor problem and how the motors in the plant are loaded may point the way to a large saving in the power bill.

E. F. CARLSEN.

Chicago, Ill.



Easily Made Chain Clevis

A SMALL clevis comes in handy on many rods, doors or lever connections operated by light chain around the plant. Unless specially ordered, many times this type of clevis is hard to procure. I have used the jaw end of a fairly heavy discarded automobile brake rod for this purpose with success. Simply saw off the rod and smooth up the back of the jaw on the emery wheel and the job is done. One of these clevises is shown on the end of a chain in the illustration.

Missouri Valley, Ia. FRANK W. BENTLEY, JR.

Motor Test Discloses Single-Phase Operation

SINGLE-PHASE operation of a group of motors on a polyphase circuit sometimes escapes the attention of maintenance men. As an example, a blown fuse of 400-amp. capacity on a three-phase feeder was not found until a regular routine motor test was made on one motor— the voltage and ampere readings of which were found unbalanced.

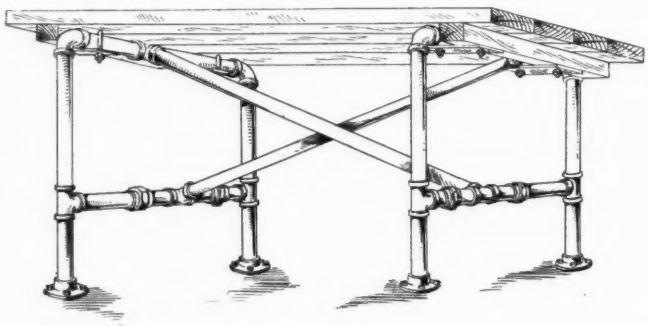
The process was continuous, and two 50-hp. and two 25-hp. motors were connected to the circuit. The circuit was checked, and when the fuses on the feeder were tested one was found blown. None of the motors were fully loaded, which prevented them from being seriously overheated. At no time were they all shut down, consequently any one could be stopped and started again because the running motors acted as phase converters and provided three-phase power.

Such a condition of single-phase operation may be guarded against by watching for overheated motors on any feeder group, by regular testing of feeder fuses, by routine motor tests, and by regular tests of voltage on each feeder to detect unbalanced voltage.

Alcoa, Tenn. J. ELMER HOUSLEY.

Work Bench Frame Made From Pipe and Fittings

PROBABLY every engineer and mechanic has been confronted with the problem sometime in his life of constructing a substantial work bench. The diagram shows the results of my efforts. The frame is made from 1-in.



pipe and fittings. Planks $1\frac{3}{4}$ in. thick are used for the top of the bench. These are fastened to cross pieces which are held to the pipe frame work with $\frac{1}{4}$-in. bolts, the bolts being used in pairs to hold short iron straps against the under side of the pipe.

Cleveland, O. C. O. MATTHEWS.

Effective Packing Gland of Standard Pipe and Fittings

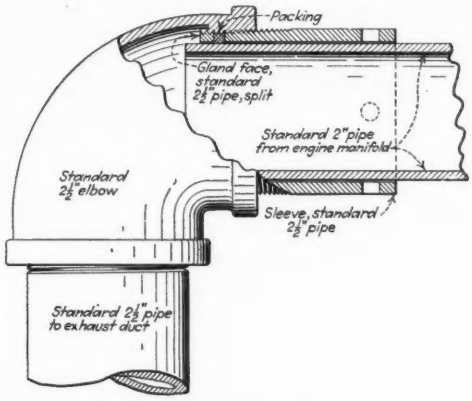
EARLY in the development of the Internal Combustion Engine Laboratory at Lehigh University (Described in *Power* Feb. 9, 1931) the need became evident for a simple, dependable and inexpensive packing gland to connect individual engine exhaust lines to a common duct. Apparent lack of a suitable standard device of this kind and a very pressing need for it led to research in our own laboratory on a type of gland that would more nearly meet the situation than any of the known types on the market. The result was the arrangement illustrated in the accompanying drawing.

From the main exhaust duct for the two banks of five engines, and opposite each engine position, laterals of standard $2\frac{1}{2}$-in. pipe were run through hoods imbedded in the concrete floor slab. These terminated in short risers topped with 90-deg. elbows. From the exhaust manifold of each engine a standard 2-in. line was run to the $2\frac{1}{2}$-in. elbow. At the junction of these two lines the packing gland was assembled as follows:

A section of $2\frac{1}{2}$-in. pipe, approximately two threads in length, was split and screwed into the elbow until held only by about $1\frac{1}{2}$ threads. The unthreaded end of the

2-in. line telescoped by a half nipple of 2½-in. pipe was inserted in the elbow and made up at the engine end. Woven asbestos packing was then placed in the space between the 2-in. pipe and the elbow inlet, and the whole was compressed and made gas tight by drawing the sleeve snug with a spanner wrench.

In addition to furnishing a simple, cheap, gas-tight joint, this packing gland provides for elongation and


Packing
Gland face, standard 2½" pipe, split
Standard 2" pipe from engine manifold
Standard 2½" elbow
Sleeve, standard 2½" pipe
Standard 2½" pipe to exhaust duct

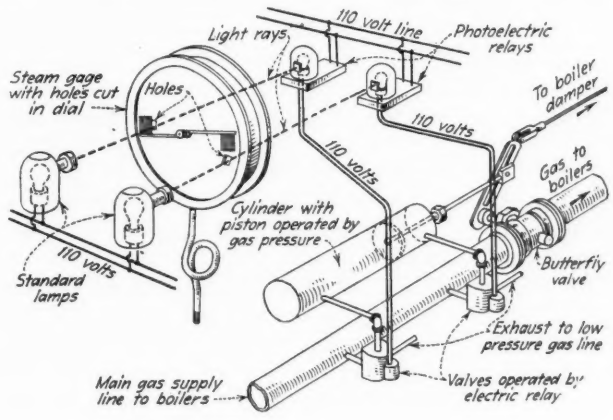
contraction of the engine exhaust line without transmitting any attendant stress to engine or engine mounting. Ten such glands have been in almost daily use during the past two years without replacement and without adjustment.

Bethlehem, Pa. G. B. THOM
Dep't Mech. Engrg.
Lehigh University.

Electric Eye Controls Gas-Fired Boilers

To THE plant engineer of the Godchaux Sugar Refinery, Reserve, La., goes credit for this ingenious pressure-control apparatus (shown in the diagram and published in *The Locomotive*). A small hole is cut in the steam-gage dial at the pressure for which regulation is desired. A similar hole is cut on the other side of the dial but not quite opposite the first one. The regular gage hand is replaced by a long hand with metal flags large enough to cover the holes.

As steam pressure increases, the right-hand flag moves down in front of the hole, thus interrupting the beam of light to the photo-electric cell. This causes the relay to energize the coil of the relay valve on the gas line and open the valve. Gas under pressure enters the cylinder



from the main and moves the piston, which in turn partly closes the butterfly valve in the line to the burners.

As the fuel supply decreases, steam pressure drops. When the pressure reaches a predetermined low limit, the flag on the left covers its corresponding hole in the steam gage, and its photo-electric relay opens the butterfly valve in the gas line. More fuel enters the burners, and steam pressure again increases. This device is said to regulate pressure within a limit of three pounds. The butterfly is so adjusted that gas cannot be turned completely off, and a by-pass is provided around the valve for use in case it is desired to cut the regulator out of service.

Ejector Saves Coal on Heating System

A FACTORY heating system that had formerly run on about 5-lb. gage pressure was changed to operate on a vacuum by the use of a water-operated ejector. All of the air valves on the radiators were removed and ⅛-in. air vents run to the boiler room and tapped into a 1¼-in. header connected to the suction of an ejector.

City water pressure at 60 lb. was used to operate the ejector, which produced a vacuum of 8 in. of mercury. Packing glands on radiator valves were the greatest sources of air leakage. Careful repacking removed the trouble. The ejector was operated twice a day for about 20 min. and allowed heating to be done on 1 to 2 lb. gage pressure, the owners reporting a coal saving of about 15 per cent.

In some localities it might not be advisable to use water to operate the ejector. Compressed air was used in another heating plant with very good results. When the ejector is not in operation the valve on the air-pressure line must be tightly closed to avoid air leakage back into the heating system. J. S. CARPENTER.

York, Pa.

Care of Ice Cans and Tanks When Out of Use

WHEN an ice tank is taken out of service, methods of taking care of the cans vary. Sometimes the cans are left in the brine, it being thought that the film on their surface will prevent corrosion. In other cases the cans are removed, cleaned and painted, cleaned and oiled or sometimes just cleaned. Cleaning, followed by painting or oiling, is the practice recommended in England. If the brine tank is to be out of use for some time, the existing brine is drained off and the tank and coils are cleaned. The parts of the coils which will not be covered by water are painted. The tank is then filled with water to the normal brine level, additions being made to maintain this level if necessary.

Leaving the brine in the tank is not recommended; the protective film which forms will only protect against corrosion at operating temperatures. Also there will be a slight evaporation which will lower the brine level and cause corrosion at that level. The temperature of the brine when laid up will be considerably higher than when operating normally, and this will also tend to cause corrosion. W. E. WARNER.

Welwyn Garden City, England.

CURRENT COMMENT

Power-Driven Idlers for Conveyor Belt

I READ the article on conveyor belts in the October number of *Power*. It may be of interest that on long conveyors, power driving the idlers has been found successful, principally in Germany. The stress in the belt and its wear is considerably reduced. It is usual to drive every second or third idler by means of an individual motor. The motors are accurately controlled as to speed, so that the surface speed of the idler is the same as that of the belt.

This method allows power to be supplied to the belt at various points along its length instead of at the head pulley only. One of the advantages of this type of drive is that it permits using a thinner belt and smaller head and tail pulleys. These advantages, together with reduced belt wear experienced, are said to more than compensate for the additional cost of the motors and control gear needed. W. E. WARNER.

Welwyn Garden City, England.

Meter Versus Orifice For Chemical Feed

IN THE September number of *Power*, under the heading of "Chemical Feed for Hot Lime Soda Softeners," comment is made by S. B. Applebaum, on the so-called disadvantages of the orifice in the raw water line leading to the softener, as compared to using a water meter.

The writer has had quite a little to do with hot lime-soda softeners using orifice plates, particularly in the Pittsburgh district, where boiler loads are quite variable. In no case under his observation has it been necessary to replace the orifice finally selected for the raw water with smaller or larger sizes.

One orifice plate takes care of quite a large variation in load conditions. Not having a May 10 number of *Power* before me, I do not know why R. F. Hollis felt it necessary to select from eight sizes of orifices to get the best results. Certainly in starting off a water softener the question of the proper size orifice plate has to be determined from the actual load conditions, hence a number of sizes are furnished with the equipment, but once the proper size is installed, there should be no occasion under normal conditions for changing it.

The waters in the Pittsburgh district are notoriously bad, so much so that the simplest possible proportioning medium placed in the raw water line is highly desirable. An orifice is the simplest possible medium that can be devised. Such orifice would have to be entirely eaten away by the corrosive action of the water before the accuracy of proportioning would be greatly impaired.

On the other hand, if a water meter were placed in the raw water line, such as Mr. Applebaum suggests, it is reasonable to expect that due to the free acid and mud in the raw water, its accuracy in time would be affected, and for that matter the internal mechanism completely destroyed. Such a meter may be all right in clear raw water, but it does not appeal to the writer as being practical for muddy and corrosive water.

It seems to the writer that in order to obtain the same accuracy over as wide a range of flow with a disk meter as can be secured with six or eight raw water orifice plates, it would be necessary to use several meters.

A $1\frac{1}{2}$-in. meter will pass approximately 115 gal. per minute at a pressure loss of 5 lb. This meter will be reasonably accurate for a flow as low as 20 gal. per minute, or approximately one-sixth of its maximum capacity with 5 lb. pressure loss. If the meter becomes fouled as a result of passing unfiltered water, or worn with usage, it is not accurate over as wide a range. On the other hand, one raw-water orifice plate is accurate for a minimum flow of approximately one-sixth of maximum flow, or about the same range as the meter in good condition. If the operating conditions demand a change of raw-water orifice for desired accuracy, it will therefore also be necessary to change meters for similar variations in water flow. DAVID HENDERSON.

Pittsburgh, Pa.

Protecting Polyphase Motors Against Single-Phase Operation

I HAVE read with interest in the December *Power*, Mr. Glenn's short article on protecting polyphase motors and would like to make a few comments on some of his statements and conclusions. He claims that a 43.5-amp., 40-deg. C., general-purpose induction motor, with a safe loading service factor of 1.15 is equivalent to a 55-deg. C., 50-amp. motor. This I consider to be incorrect. It is shown that with 60-amp. fuses for overload protection the motor current can be at least 66 amp. continuously and may reach 75 amp. before the fuses blow.

The conclusion is that the motor would have no protection against damage from continuous overload, as it has already reached the limiting hot-spot temperature of 105 deg. C. with a 50-amp. load. This is in agreement with my contention on page 94 of the August number of *Power*, that a fuse which does not blow until the motor is carrying 50 per cent overload, in most cases gives no protection against excessive heating either when operating 3-phase or single-phase, but as Mr. Glenn's motor has a 55-deg. rise at 50 amp., its hot spot temperature would be 110 deg. and not 105 deg. as he says.

According to the A.I.E.E. rules the limiting temperature for a motor with Class A insulation (see page 318 of December *Power*) is 90 deg. C., and an allowance of 15 deg. C. is made for the hot-spot temperature inside the motor. With a standard ambient temperature of 40 deg. this permits a 50 deg. rise only. How then can a motor be given a safe continuous overload rating of 115 per cent by the manufacturer, if it has 55-deg. rise at this rating?

The 40-deg. general-purpose motor is guaranteed to carry full load continuously, with a temperature rise not exceeding 40 deg. in a room temperature of not more than 40 deg., when voltage and frequency are normal. It is guaranteed to carry full load safely, that is, within the

90-deg. temperature limit, in a room temperature not exceeding 40 deg., with a voltage variation of 10 per cent above or below normal, a frequency variation of 5 per cent above or below normal, or a combined voltage and frequency variation of 10 per cent above or below normal, the frequency varying opposite to the voltage. It generally carries a guarantee from the maker that it will operate safely, that is, within the 90 deg. limit, when the load is 115 per cent of its normal rating, provided that the room temperature does not go above 40 deg. and that the voltage and frequency are normal.

Most 40-deg. general-purpose motors can be given a service factor of 1.15, for the average 40-deg. motor has a temperature rise of less than 40 deg. at full load. Some standard makes of the higher-speed motors will carry 50 per cent overload safely, but it is a mistake to consider all general-purpose motors as being alike except in respect to the 40-deg. full-load guarantee.

Motors may be designed to have maximum efficiency at three-quarter load, full load, or perhaps 10 or 15 per cent overload. Some designers consider that a maximum efficiency of three-quarter load is the best for average conditions of service.

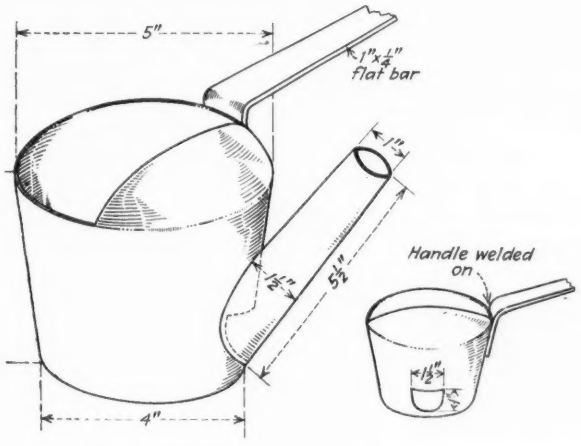
The curves of temperature rise with load for these motors would be different. A failing efficiency with overload raises the temperature quickly, while a rising efficiency with overload raises the temperature at a slower rate. So that while most 40-deg. motors can be safely loaded up to 115 per cent of the full-load continuous rating, some which are closely rated at full load may not carry this overload safely, particularly if voltage and frequency conditions are not normal.

Mr. Glenn may be correct when he says that compared with the other causes of failure in service, those due to overload are relatively few, but nevertheless many motors are burned out from this cause. H. WILSON.

Toronto, Ont.

An Improved Babbitt Melting and Pouring Pot

READING the interesting article by John James in the November *Power* prompts me to describe a babbitt melting and pouring pot which I designed and constructed a few months ago and which is shown in the diagram. The body portion and spout is made from $\frac{1}{16}$-in. black steel sheet, and the parts are welded together. The small diagram on the right shows the pot body before the spout was welded in position.



The hole in the pot body is semi-circular, as it is found in babbitting practice that a semi-circular hole of a suitable size gives better results than a round hole. It keeps impurities or dross from entering the bearing, and the pot gives a clear flow of molten babbitt from the bottom.

Experience has shown that babbitt metal must be mixed to homogeneity if best results are to be obtained. If babbitt is allowed to remain still while in the liquid state, it tends to separate into layers. The lead, being heaviest, gradually works toward the bottom and the lighter ingredients to the top. Babbitt-lined bearings poured from metal in such a state sooner or later develop trouble in service. A. EYLES.

Manchester, England.

Welding Bars on a Motor's Rotor

REGARDING the first part of Mr. Hope's article on "Hints for Doing Welding Jobs About the Plant" in the December *Power*, the writer has had a similar experience. The welding was done on the rotor bars of a 7½-hp., 1,800-r.p.m. motor. As in Mr. Hope's motor the bars were originally soldered to the end rings. The bars can be easily brazed if the work is done right. I know that I started wrong and I believe that Mr. Hope did likewise. My trouble was caused by not removing the solder from the bars and ring before starting to braze.

Solder is composed of tin, lead and antimony with different percentages of each depending upon the melting point, which is from about 370 to about 450 deg. F. Tobin bronze used in welding contains, according to Marks Handbook, 58 to 60 per cent copper and about 40 per cent zinc, the remainder being iron, tin and lead. Its melting point is around 1,640 deg. F. Thus it is evident that to braze with bronze the temperature of the work must be raised to around that value.

Ordinarily the welding flux used prevents forming a film or oxide and the melted bronze adheres to the work and a good braze is obtained. To braze parts that are covered with solder is difficult. Lead and zinc in the solder form an oxide film on the work at high temperatures that prevents the melted bronze from sticking to the metal. A braze made under these conditions takes longer to make and is not usually as satisfactory as one where solder is not present.

The editor's comment on the welding-in-water method is correct. I find that there is a noticeable difference in the amount of heat necessary to weld or braze work partly covered with water. Like Mr. Hope, I placed one end of the rotor in water for by so doing I was able to apply a greater volume of heat to the bars and ring and thus burn up the tin and lead in the solder and make the bronze stick without fear of damaging the rest of the rotor. BURTON W. WHEELER.

Rockland, Mass.

Berlin West—Correction

IN THE article describing the West station of the Berliner Stadtische Elektrizitätswerke, A.G. in the October number of *Power* it was erroneously stated that brown coal was used as fuel. The coal used is a black pit-coal from the Silesian and Westphalian district.

DIESEL DEVELOPMENTS

● IN PREPARING for the annual review number of *Power,* the editors assembled a considerable amount of information on the latest developments in the oil and gas engine fields which could be sketched but briefly in the space available. Yet, several of these developments were so important that they could not be dismissed with short notice. Summaries are, therefore, given on the following pages.

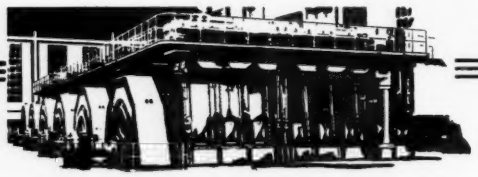
● THE ERREN engine, while not a strictly diesel development, is nevertheless associated directly with the trend of diesel advancement. Here is proposed an alternative method of utilizing off-peak power, and one offering unusual savings because of proper waste heat utilization and application of economic factors.

● THE NEW Michel diesel is strikingly different from its predecessor and from the American Michell crankless unit. Its compact, 3-crankshaft arrangement may offer possibilities in several fields.

● INJECTION, combustion and costs are always of interest. Here then, is a short resumé of German developments in this direction, taken by our correspondent from papers presented at the recent technical meeting of the V.D.I. in Berlin, and some British oil engine working cost figures.

● FUELS, particularly for automotive diesels, were discussed at Detroit and Philadelphia last month. As in most arguments, there are two sides—one that of the oil refiner, the other that of the diesel engineer. Here are both sides.

● ISOLATED diesel plants are becoming fairly common. Hudson River Stone Corp. has installed one with both battery and utility standby.



HYDROGEN ENGINES

For Off-Peak Power Utilization

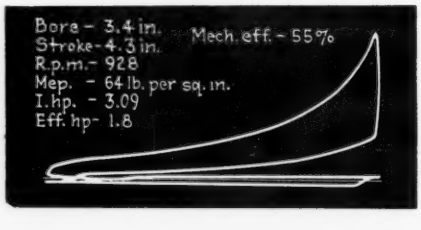
By EDWIN P. A. HEINZE
Berlin Correspondent, Power

EXCESS power production at off-peak periods and during load fluctuations, particularly in hydro plants, has always offered a problem, particularly where facilities for pump-storage are not available. A new engine, the Erren, burning hydrogen mixed with oxygen, air or fuel oil, however, is suggested as a solution. The hydrogen may be produced as a chemical by-product or by two types of electrolyzers invented in Germany which supply the gases separately in a pure state at pressures of 3,000 to 4,000 lb. per sq.in., without a compressor. These electrolyzers have been in practical service for years, and companies are now being formed for their exploitation. They have no moving parts and work cheaply and efficiently. Gas produced at these high pressures can be stored in small, high-pressure containers and piped long distances through small-diameter steel pipe. The oxygen produced by the electrolysis can be used with the hydrogen as an engine fuel or can be sold.

While hydrogen's thermal efficiency is not as high as that of coal gas, it is produced by this method so cheaply that it offers considerable advantages. Further, hydrogen is wholly innocuous, and burning with air it generates steam and nitrogen, both of which are harmless and can even be inhaled without ill effects.

Since hydrogen is exceedingly explosive as soon as mixed with air or oxygen, considerable difficulty was encountered in attempting to construct a hydrogen engine. This has been overcome by using foolproof valve arrangements, which make mixture of the gases impossible before they are within the cylinders. One experiment has already employed compression ratios exceeding 12 to 1. Further, the supposition that a motor fed with hydrogen will not work at all (because of the gas mixture contracting instead of expanding due to generation of steam) has also been proven wrong. When hydrogen and air mix, it is assumed the hydrogen molecules combine with the oxygen molecules of the air, leaving the nitrogen, which surrounds the united hydrogen and oxygen molecule. When ignited, the enormous heat generated is taken up by the surrounding nitrogen and its steam nucleus. These act as a highly efficient expanding medium.

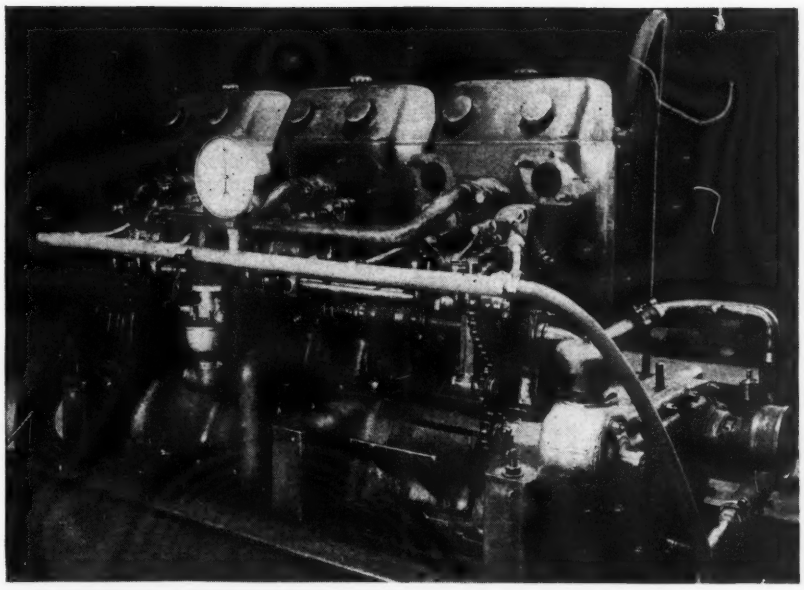
A typical indicator diagram with hydrogen and air as fuel in a one-cylinder side-valve engine.



The thermal efficiency of hydrogen engines approaches 50 per cent, and units can be built of any size guaranteeing not to exceed 21.2 cu.ft. per hp.-hr. for maximum gas consumption. Since normal trade hydrogen has a lower thermal value of 265 B.t.u. per cu.ft.; this gives a thermal efficiency of 45 per cent. Makers claim consumption as low as 17.65 cu.ft. per hp.-hr.

Hydrogen engines are the invention of the German engineer, Rudolf A. Erren. In design they are similar to normal gasoline engines from which they differ mainly by being provided with a special hydrogen feed valve and its operating gear. Design of the hydrogen valve used depends on the fuel.

Practically any existing type of in-



A converted 100-hp. NAG gasoline engine, to work on hydrogen and air and alternatively as a normal gasoline engine. Normal inlet and exhaust valves are in head, hydrogen valves are arranged horizontally in the side of the head below exhaust ports and operated by camshaft

ternal combustion engine can be converted to work on hydrogen, even compression ignition engines, provided they are fitted with electric ignition. Further, a hydrogen engine working on compression ignition but without electrical ignition is now being constructed. The writer has tested a number of converted engines including single-cylinder horizontal and standing, four- and six-cylinder engines of both former diesel and gasoline types.

The conversion to operate on hydrogen and air was carried through individually, although, of course, standard fittings can be evolved for any one type of engine. One conversion may serve as an example. Hydrogen valves somewhat similar to those normally employed on engines are contained in a casing screwed into the cylinder head. The projecting valve stem is actuated by a rocker generally operated in the converted engines by a camshaft arranged on a bracket at the side of the engine and driven by a roller chain off a sprocket on the extended end of the normal camshaft in the crankcase or on the crankshaft. The valve casing communicates through a short lateral pipe with a feed pipe common to all valves, and an ordinary rubber hose supplies the gas to this distributing pipe or manifold. Hydrogen is normally fed at atmospheric pressure or with a very slight over-pressure of 8 in. water column. Air comes in through normal inlet valves.

Illustrated is a big 100-hp., 6-cyl. NAG engine now being installed for service trials in a rail car. Another experimental engine is a converted Cyklon car motor with four cylinders and side valves. Bore and stroke respectively are 2.61 in. and 3.75 in. The hydrogen valves are fitted in the head in between the spark plugs and a special camshaft with interchangeable cams is arranged on a bracket along one side of the detachable cylinder head casting and driven by roller chain off the ordinary camshaft. Normal air intake manifold and carburetor are retained, and cooling is effected by a connection with the ordinary water main. The motor is direct-coupled to a generator.

A direct comparison between gasoline and hydrogen operation of this engine showed 17½ amp. at 180 volts under gasoline operation and 19-20 amp., at 195 to 200 volts under hydrogen, or 27 per cent better.

Erren engineers hold that generally the use of hydrogen in a normal gasoline motor in which the compression ratio has not been raised, will effect a reduction in maximum power output of 3 to 5 per cent. Such a decrease, however, can readily be compensated for by slightly increasing the hydrogen feed pressure, that is, by virtually supercharging the hydrogen. Large Erren units, built from the start for working on hydrogen, are to have a compression ratio of 8 to 1.

Erren motors can also be operated on mixtures of hydrogen with normal liquid fuels such as gasoline and heavy oils of the lowest grade. The liquid fuels are generally vaporized or atomized by carburetors or injection pumps in the normal manner, hydrogen being introduced at a suitable moment at atmospheric or high pressure as the case may require. A 50-hp., 4-cyl. bus engine running on ordinary gasoline vapor increased power 30 per cent when a small quantity of hydrogen was added. Gasoline consumption simultaneously dropped almost 50 per cent. The increase of flexibility was also particularly notable. The engine would idle with gasoline only down to 220 r.p.m. without misfiring or stalling, but when hydrogen was introduced it would idle perfectly at 159 r.p.m. These results have been confirmed by repeated tests on several different engines.

I personally conducted a test with an engine running on hydrogen and oxygen fed in the proportion of two volumes of the former and one of the latter. These two gases, burning together, form pure steam, which taking in less room than the original gases, exerts no working pressure. Therefore, some sort of expanding medium has to be introduced. The Erren company has developed several methods. In one a certain amount of air is allowed to come into the cylinder for expansion. But the more important method, the one I used, provides for the use of steam as expanding medium, the steam being supplied by the engine's own exhaust.

The 4-cyl. car motor which I used was converted in a rather rough-and-ready manner to operate on oxy-hydrogen gas. The ordinary hydrogen valve was retained and an air intake manifold wrapped round with heat insulating material was fitted, it being connected by a short pipe, also heat insulated, with a three-way cock in the exhaust pipe. The air manifold had an opening where the carburetor is usually fitted and which can be closed. The three-way cock was arranged to shut off the exhaust from passing through the pipe length behind it into the atmosphere and conduct it into the air manifold. Oxygen was introduced into the latter through a small jet, which was connected by a rubber hose with the oxygen container, a normal trade tank.

The motor was started on hydrogen and air and ran coupled with the generator all the time. Then the oxygen valve was opened and engine speed increased. Then the exhaust pipe was not only closed by the three-way pipe but also by the outer end being bunged up. The exhaust steam was now forced to pass into the air intake manifold, where it mixed with the oxygen and was drawn into the cylinders again and again. Finally, also, the air intake manifold was closed, and the engine worked entirely on a closed circuit. There was a loss of power evident, but the engine continued running for over half an hour, when I requested that it be stopped.

This experiment seems physically impossible since the back pressure of the steam accumulating in the system needs must throttle the engine to a standstill. The reason this does not occur is that a large amount of the steam condensed in the pipe and manifold.

Another engine, a converted single-cylinder diesel, was provided with separate hydrogen and oxygen feed valves and spark plug for which battery ignition had been furnished. This works very satisfactorily on the "closed circuit" system with a compression ratio of 12 to 1. Exhaust steam is not fed directly into the inlet port but into a heat-insulated receiver as large as the engine's cylinder, and from this the piston draws in steam, which in the cylinder becomes mixed with hydrogen

and oxygen. A valve in the receiver, set to open at a low pressure, allows surplus steam to escape through the pipe into a vessel with water where it condenses. This, therefore, was the equivalent of the normal exhaust. The surprising element, however, is that the exhaust steam is evidently very small in quantity for it does not as much as raise a ripple on the surface of the relatively small vessel with the condensing water.

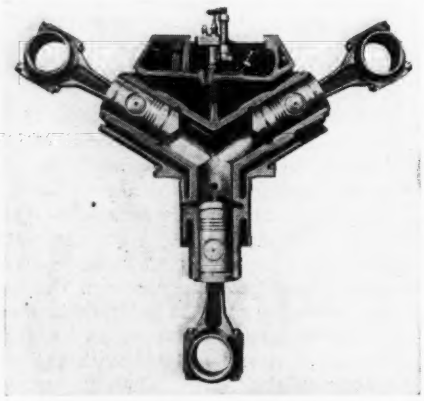
Such an engine has a wide potential field of application, for instance, in locomotives in mines. It requires no air and the exhaust can be used to moisten the air and allay dangerous dust formation. Also in submarine vessels the engine will prove useful, as disposal of the exhaust steam presents no difficulties. Oxygen and hydrogen could be stored during surface operation of the vessels.

One point further might be mentioned, the possibility of utilizing the exhaust of Erren motors directly. Since it is innocuous it can be used for heating rooms or driving low-pressure steam engines and turbines. In this manner the high thermal efficiency of the engines can be increased still further. In the case of a water power plant to be erected in Germany, where large Erren units are to supply peak current, their exhaust will be used to heat a large greenhouse establishment covering 56,000 sq.ft. Recovery is expected to be so effective that only 10 per cent of the heat supplied the engines will be lost.

THE MICHEL DIESEL

A High-Speed, 3-Crankshaft, No-Valve Unit

By EDWIN P. A. HEINZE
Berlin Correspondent, Power



Radial arrangement of the pistons about the central combustion space.

A NEW type of high-speed diesel engine, developed by Michelmotor Company, Hamburg-I, Paulstrasse 2, Germany, is claimed to constitute a marked improvement on the conventional type. This is evidenced by test results of two authorities, Dr. S. J. Davies of King's College, London, and Prof. Dr. A. Naegel of Dresden Technical University. This engine requires only 1.53 cu.in. of swept volume per hp., and the lack of vibration, high degree of flexibility and exceptionally efficient combustion over the whole speed range are further points favorably commented on by these scientists.

The engine is wholly different from the one the company developed some years ago which had cams as power-transferring media instead of crankshafts. In the new engine, the star cylinder arrangement has been retained. Three radially arranged and water-jacketed cylinders cast in one block have a common combustion chamber, the form of which is practically determined by the piston crown shape and piston position. The engine works on the two-stroke principle. Any number of star cylinder units can be combined, and these are so mounted in a frame that they stand on one cylinder, the sump being attached in the normal fashion to the row of bottom cylinders. The engine has no valves, the place of these being taken by ports opened and closed by the pistons. The upper cylinders of each star unit are provided with the scavenging ports, while the lower cylinders carry the exhaust ports.

The pistons of each row of cylinders work on a common crankshaft. The three shafts are provided at their rear ends with additional cranks somewhat shorter in throw length than the piston cranks and connected with one another by a single-piece triangular frame of light alloy. This frame deals only with fairly light forces because of the piston arrangement. Drive is taken from the lower crankshaft, which carries the flywheel.

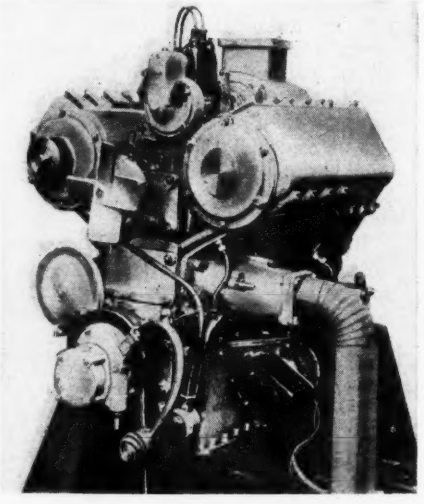
This lower crankshaft has the piston cranks set to give the exhaust pistons a lead of 24 deg. on the scavenging pistons. This arrangement, essential to secure adequate relief of pressure in the cylinder before inlet ports are opened by the upper pistons, gives a minimum volume of combustion space not identical with the inner dead center of any piston. Minimum volume, that is state of highest compression of air charge, is attained 8.2 deg. before the two upper pistons reach their inner dead center and 15.8 deg. after the exhaust piston has passed its inner dead center. The lower crankshaft thus takes 70 per cent of the power at full load, the others taking 15 per cent each.

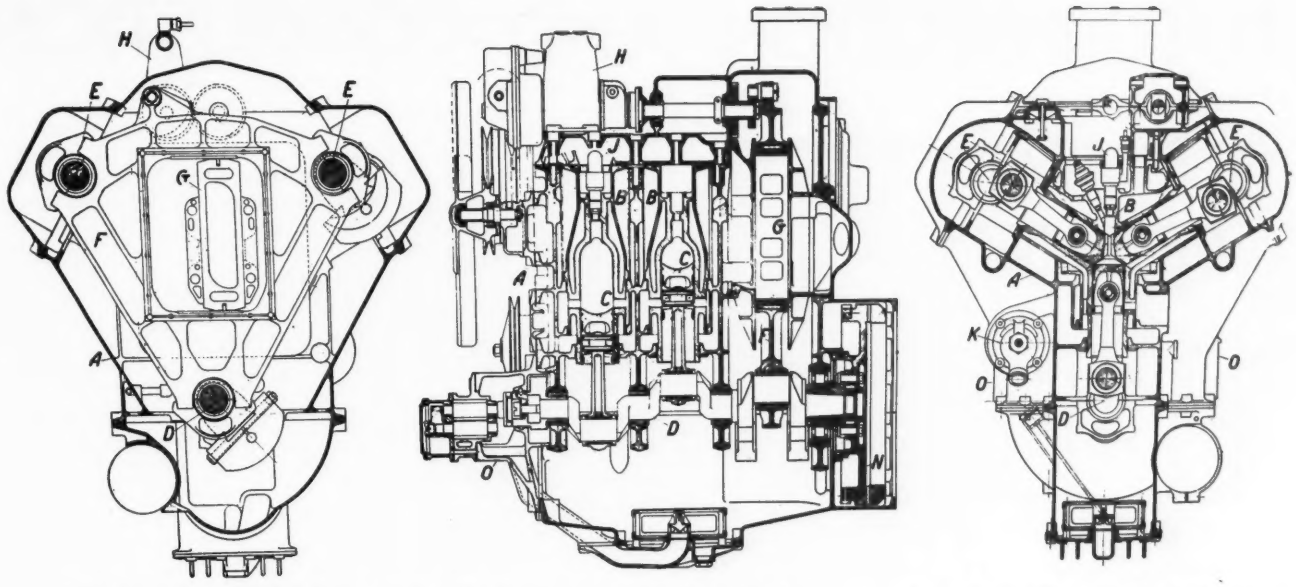
The offset motion of the exhaust piston aids in achieving an excellent mixture of air and fuel charge owing to the powerful piston swirl directed against the incoming fuel spray. A Bosch injection pump and automatic needle valve nozzles are employed. The latter stand upright between the upper cylinders of each star and direct the spray into a cylindrical chamber communicating with the combustion space. To facilitate starting the cold engine, heating plugs are fitted in a recess of the cylindrical spray chambers or tubes.

Consider the moment of minimum combustion space volume as 0 deg. of crankshaft rotation. Timing then is as follows: All ports are closed and the power stroke begins. After 109.6 deg. crankshaft rotation, the exhaust pistons open their ports, which remain open for 108.9 deg. The scavenging pistons open their ports 32.6 deg. after the exhaust pistons at 142.2 deg. of the crankshaft cycle. Scavenging air is fed with 21 to 22 lb. per sq.in. pressure. The exhaust pistons close their ports at 218.5 deg. Supercharging sets in for the next 15.8 deg. because the scavenging pistons do not close before 234.3 deg. Compression then begins, and at 323 deg. the 25-deg. injection of the fuel starts, at first very vigorously.

No gears are employed in the engine for driving the various components, such as injection, lubrication and water circulation pumps, since the coupling triangle, describing a circling move-

An experimental Michel engine of the new type.





Section of a 2-star Michel diesel. The letters denote: A, engine body for the cylinders; B, cylinders; C, pistons; D, lower crankshaft; E, upper crankshaft; F, coupling triangle; G, slide valve in scavenging pump box; H, fuel injection pumps; J, fuel nozzle; K, water pump; N, flywheel; O, suspension lugs.

ment, is employed to drive these by means of cranks on their shafts.

Novel also is the design of the scavenging pump, which according to Dr. Davies has a volumetric efficiency ranging from 75 per cent at low speed to 94 per cent at high speed. The pump is a deep box frame incorporated within the coupling triangle central space. The box frame circles between two plates fixed in the engine housing, and an air-tight fit between it and these plates is achieved by spring-loaded strips on the frame edges. Fixed on the plates inside this box is the stationary part of a slide valve, through which passes the slider. The latter, able only to move up and down in its guides, forms an air-tight partition in the box and is pressed up and down by the top and bottom walls of the box frame. Meanwhile the side walls of the latter alternately move towards and recede from the partition during their circling movement, engendering a pumping action as the volumes on both sides of the sliding valve alternately contract and expand. The slide valve opens alternate ports connecting the expanding side with the atmosphere, so fresh air is drawn in while simultaneously the contracting side is connected with the air ducts leading to the scavenging ports.

This scavenging pump has proved its efficiency in a four-star truck engine of 70 hp. output at 1,200 r.p.m., where it has already done more than 20,000 miles of road service. Lubrication of the pump is effected by oil vapor.

A prototype of future engines is a single star-cylinder experimental engine of 2.61-in. bore and 4.52-in. stroke, giving a piston displacement of 74.8 cu.in. The compression ratio is 15.07 to 1 and it delivers 55.25 hp. at 2,058 r.p.m. with a scavenging air pressure of 21 lb. and a b.m.e.p. of 139 lb. per sq.in. Owing to the requirements of research work, however, this engine has a separate scavenging pump of the Roots type driven by an electric motor. Power requirements of this motor must be deducted, leaving an effective output of 49.45 hp., equivalent to 1 hp. per 1.52 cu.in. of swept volume.

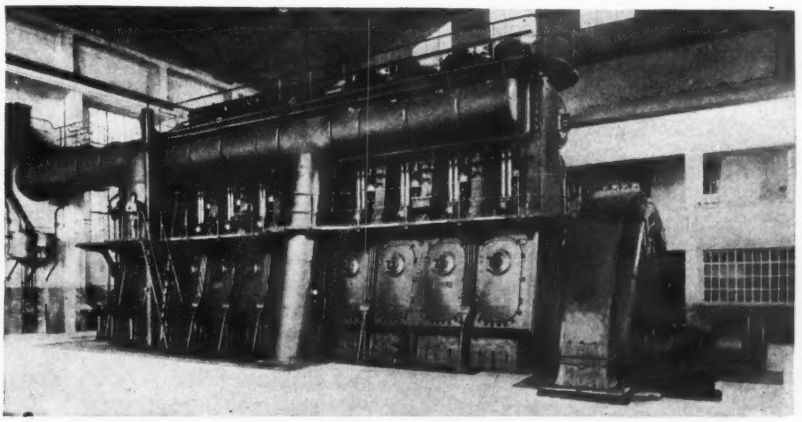
However, fuel consumption in this particular engine is not as satisfactory as it might be. It amounts to 0.539 lb. per hp.-hr. for the effective output. As the engine is mechanically not in good condition and has greatly over-dimensioned moving parts, a new engine would show considerable improvement.

The two-star engine represented in the accompanying sectional drawings was built while development work was still in progress and is, therefore, not constructed in accordance with latest experience. The most satisfactory bore stroke ratio has proved to be 1.74, while this engine has 1.3. It has a bore of 2.85 in. and a stroke of 3.72 in., giving a piston displacement of 146 cu.in. The compression ratio is 15.1 to 1, and it delivers 65 hp. at 1,990 r.p.m.

The design offers manifold advantages apart from high power output and compactness of size. Owing to the total stroke being subdivided into three equal parts executed by three pistons, the speed of the latter does not exceed 1,240 ft. per min. at 2,000 r.p.m. This fact and the absence of valves, camshafts and gears should aid durability. The engine actually consists of fewer parts than conventional engines. All parts are readily accessible. The upper crankshafts, connecting rods and pistons admit of quick removal after which the star cylinders can easily be taken out.

One more technical feature deserves mention, the shape of the top piston rings. In two-stroke engines these are likely to gum up because the pistons always work against a pressure directed towards the crankshaft. To avoid this, the top rings have a sinusoid shape and trapezoid cross-section.

A four-star engine now in preparation has a bore of 2.61 in., a stroke of 3x4.52 in. and a piston displacement of 299 cu.in. It will develop 160 hp. at 2,000 r.p.m. and will weigh only 1,190 lb. or 7½ lb. per hp. Its over-all length will not exceed 46 in., while the greatest breadth across the top will be 34.6.



A 10,800-hp. double-acting, 2-stroke Sulzer diesel in the Maigrauge (Fribourg) power plant. A similar engine with slightly larger bore is being added to the 37,500 b. hp. of the world's largest diesel station at Shanghai to bring its capacity up to about 50,000 b. hp.

FUEL INJECTION AND COMBUSTION

As Shown by Studies in Germany

By COLMAR KRAUSE
Berlin Correspondent, "Power"

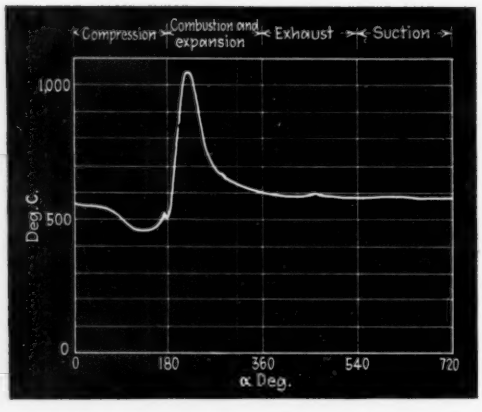
UNTIL recently there has been but little known about what happens in the diesel engine during the injection and combustion of liquid fuel. The rapidity of the process and the high pressures and temperatures involved render it difficult to investigate these phenomena. Reports presented by Prof. A. Nagel and Dr. Ing. O. Holfelder at the scientific meeting of the Verein Deutscher Ingenieure recently showed that remarkable progress has been made, principally by application of very sensitive and inertia-free electrical measuring instruments.

The piezo-electric method is used to indicate the pressure cycle in the high-speed diesels. This method is characterized by the capacity of certain quartz crystals to charge themselves with electricity whenever mechanical forces act on them in a fixed direction relative to the axes. The lift of the jet needle is measured by the aid of a condenser, the capacitance of which is changed by needle movement. Thermocouples allow exact measurements of the temperatures up to 1,000 and more r.p.m.

Fig. 1, for example, shows the course of the temperature in the pre-chamber of a diesel running at 1,000 r.p.m. This shows a drop of temperature at the beginning of the compression stroke due to the penetration of fresh air into the pre-chamber. After a slight increase, a second short drop of the temperature is observed shortly before the upper dead center is reached, caused by the penetrating fuel jet before ignition. Propagation of flame is measured by the electrical conductivity of the flame due to ionization.

The demand for smooth-running engines has induced the investigation of all phenomena that have an influence on ignition delay. Since ignition delay at a constant r.p.m. decreases considerably with torque, the engines run very hard when being started. Professor Nagel showed the differences in the delay of ignition when driving the engines with gas oil or coal tar oil. At low load, tar oil is ignited either very slowly or sometimes not at all, thus resulting in jerky running. Conditions can be improved by adding some tetraline or by pre-injection.

Fig. 1—Course of temperature in the pre-chamber of a motor-car diesel. Full load at 1,000 r.p.m.



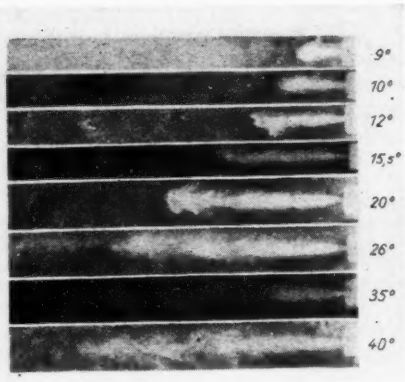


Fig. 2—Course of an injection with Bosch single-hole pin-type nozzle of 1 mm. diam. Fuel delivery during 18.4 deg. pump shaft rotation, injection delay 8 deg., jet angle, 15 deg., injection pressure 1,565 lb. per sq.in. gage, back pressure 214 lb. per sq.in., speed, 485 r.p.m. Numbers show degrees rotation after beginning of fuel delivery by pump

Dr. Holfelder reported on investigations of the Technical University of Dresden regarding the influence of the pressure of injection, the back pressure and the shape of the nozzle on the fuel jet formation. Injection nozzles were set in a pressure chamber with glass slits, and jet shadows were photographed by spark exposure of one-millionth second. This shows that the fine distribution of the jet necessary for complete combustion is far easier to obtain by increasing the back pressure than by increasing the pressure of injection. When investigating open nozzles, that is those not closed by needles, it is found that the largest angle of the jet was obtained with a nozzle having a cylindrical bore and rounded mouth edges. The largest depth of penetration, however, was obtained with conical nozzles tapered at the front end. Investigations with closed nozzles are not yet concluded. Fig. 2 visualizes the influence of an enlargement in the fuel inlet pipe, which results in an increase of the duration of injection and after spouting.

DIESEL FUEL PROBLEMS

ONE perplexing problem confronting fuel oil suppliers, also designers and operators of diesel engines, is selection of suitable fuels. Two papers on this subject were presented during January. One was "Fuels for High-Speed Oil Engines," by Max Hofmann, diesel engineer of the Waukesha Motor Co., before the Society of Automotive Engineers in Detroit, Jan. 23-26. The other was "Fuels for Diesel Engines" by W. H. Butler of the Standard Oil Co. of New Jersey and secretary of the A.S.M.E. Research Committee on Diesel Fuel Oil, before the Engineers Club of Philadelphia, Jan. 17.

According to Mr. Hofmann, the time has come when diesel designers and fuel producers must cooperate to produce a standard rating system for oil engine fuels. He explained that a high-speed diesel is more sensitive to differences in fuels than a slow-speed unit because of the greater crankshaft rotation during the fuel delay period. Turbulence of the air charge apparently has little direct effect on the delay period, nor has droplet size. It depends upon the temperature in the combustion chamber at the beginning of combustion and the self-ignition characteristics of the fuel. Mr. Hofmann suggests an adapted CFR ("Cooperative Fuels Research" — the S.A.E. test engine) engine for knock rating by the critical compression ratio method. With this or the cetene method* (or possibly a combination) a standard for diesel fuel specifications can be set, covering: gravity (preferably as specific gravity rather than deg. Bé. or A.P.I.), viscosity in deg. Saybolt Univ. at 70 deg. F., pour point in deg. F., Conradson carbon, water and sediment, sulphur content. Mr. Hofmann holds that the last three items have an important influence on the wear and depreciation of the engine as well as on carbon formation in the combustion chamber.

Mr. Butler is not so sure that sulphur and Conradson carbon are as important as some other, thus far undetermined, characteristic. He explains that diesel engineers specify fuels with-

*A full discussion of this subject can be found in "Progress in the Measurement of the Anti-Knock Quality of Motor Fuels," a report by Veal, Best, Campbell and Holaday at the S.A.E. Annual Meeting. Write Society of Automotive Engineers, 29 W. 39th St., New York City.

out knowing anything of petroleum or its characteristics. If sulphur offends, they limit it, if carbon, they limit it—and so on, thus finally obtaining a set of specifications physically impossible to meet.

The oil refiner meanwhile, for reasons of economy, prefers to make a single diesel fuel suitable also for heat-treating, kilns and other fields. He would prefer to have all diesels burn residual oils. Thus, the biggest competitor of the diesel using distillates is actually the refiner himself—for he must needs base the price for distillate on what he could get for the gasoline he could crack from it.

It is Mr. Butler's view that the diesel must eventually burn one of two types of fuels—the high-speed unit burning a distillate costing somewhere near the same price as gasoline and hence offering economies only in greater efficiency and service, and the slower-speed heavier engine burning residual fuels of the Bunker C type.

According to Mr. Butler, most important among diesel fuel characteristics is distillation or volatility. Second in importance is viscosity. Ash should not be permitted in a diesel fuel. Of the effect of sulphur he is not so certain. Of Conradson carbon he is likewise suspicious. He believes that modern engines have little to worry them in these characteristics.

Further he considers gravity to have zero effect and flash point to be merely an insurance regulation. Chemical characteristics, such as the unsaturated characteristics, can be evaluated, he explains, but nothing can be done to the fuel to change these characteristics.

Discussion brought out a variety of comments, among them the observation that diesel fuel costs will probably be influenced as much by the law of supply and demand as by production costs.

At the same meeting with Mr. Butler, L. H. Morrison, editor of *Diesel Power*, presented a paper on "The Development of the Automotive Diesel Engine" in which he explained the four lines of diesel development and latest results of research. He explained that the present trend toward diesel-driven trucks is largely an effort to cut costs in the only possible place—the fuel. Discussion brought out that the probable automotive field for the diesel is in trucks above about 3 tons. The smaller units require an engine similar to the gasoline engine and burning almost similar fuel. The diesel has the disadvantage also of being fairly deep and thus conflicting with present low-slung car designs.

Another diesel paper of the month was that of E. T. Vincent, diesel research engineer of the Continental Motors Corp., who discussed "Testing with the Farnboro Electric Indicator" before the S.A.E. in Detroit, Jan. 23-26. According to Mr. Vincent, available literature on indicating and indicators, chiefly listing their faults, has led the practical man to the conclusion that indicating an engine is not worth the time and trouble. He explains that indicators are needed for engine development and discusses indicator types.

BRITISH OIL ENGINE WORKING COSTS

THE exceedingly complete annual report of the Oil Engine Working Costs Committee of the Diesel Engine Users Ass'n is somewhat similar to the report of the A.S.M.E. Oil and Gas Engine Cost Committee, although the British work has been continued from year to year for the past ten years. A table is included in the 1932 report that gives working costs of 54 stations for the year 1931-32. It is, of course, too large for inclusion in this abstract.

An interesting comparison of the average engine costs per unit generated in British plants for the first year of the report (1922-23) and the tenth year (1931-32) is included in the following table:

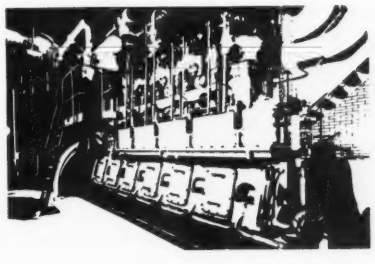
	1931-32		1922-23	
	Cost per Unit Generated*	Per Cent of Total	Cost per Unit Generated*	Per Cent of Total
Fuel	0.332	45.50	0.371	31.95
Lubricating Oil	0.052	7.10	0.084	7.23
Water and stores	0.0196	2.68	0.031	2.55
Wages (Running)	0.192	26.30	0.415	35.65
Repairs and Maintenance	0.1344	18.42	0.263	22.62
	0.730	100.00	1.164	100.00
Average Plant Capacity per Station (kw.)	1,040		573	
Running Plant Load Factor (per cent)	62.7		60	
Annual Plant Load Factor (per cent)	12.9		14.8	
Average Fuel Oil Consumption per Unit Generated (lb.)	0.667		0.714	
Rated B.HP. Hours Run per Gallon of Lubricating Oil	1,990		1,375	

* In cents, with £ at $3.35 (Jan. 15)

There has been a tangible improvement in fuel consumption, and a substantial improvement in lubricating oil consumption, only partly accounted for by the slightly increased running plant notwithstanding that the annual plant load factor has gone down by 1.9 per cent. It seems clear, therefore, that the most effective influence in reducing costs has been the increase in average plant capacity per station, which almost necessarily means the increase in size of engine units together with improvements in design in regard to ease of operation and maintenance.

The aggregate capacity of new engines installed during 1931-32 among the stations from which returns were received was not quite so large as in the preceding year, being 4,720 kw. as compared with 5,900 kw. Total output dropped over five million units during the year, average annual plant load factor dropping by 2.6 per cent.

The total output shown in the report was generated by 232 engines in the following proportions: 166 engines of 15 to 499 b.hp. generated 42.8 per cent, 48 engines of 500 to 1,000 b.hp. generated 36.8 per cent, and 18 engines of 1,000 to 2,300 b.hp. generated 20.4 per cent. Calculated on the basis of a gross load factor. But while the costs of fuel, lubricating oil, water and stores together have fallen by 17 per cent, the combined cost of labor, repairs and maintenance has fallen by 43.7 per cent,

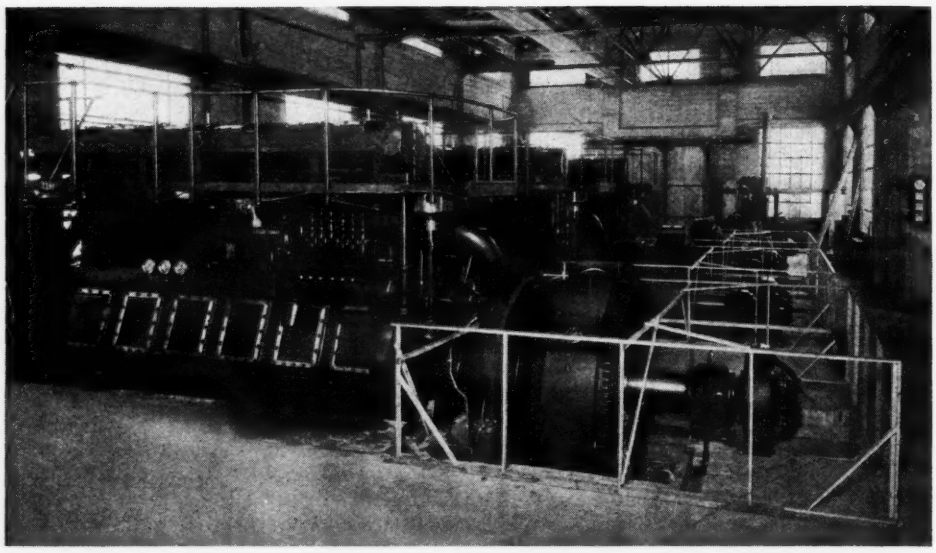


calorific value of 19,500 B.t.u. per lb. fuel, the over-all thermal efficiency (with the average fuel consumption per unit generated of 0.687 lb.) was approximately 25.5 per cent, the running plant load factor having been 63.5 per cent.

Improvement in over-all average performance under the heading of lubricating oil consumption was also good. The average figure for the whole 54 stations is 1,990 rated-b.hp.-hours run per gallon of lubricating oil. The corresponding figure for 1930-31 was 1,720, the reduction in consumption therefore being about 15.7 per cent.

One point stressed in the report is that apart from the desirability of using an intrinsically good lubricating oil, it is sometimes necessary, in order to get best operating results, to select an oil with the most suitable viscosity *at the working temperature* for the engine.

Average cost per unit generated 1931-32 was 0.134 cents for home stations and 0.119 for overseas stations, as compared with 0.158 and 0.1485 for the previous year. Average cost per unit generated for repairs and maintenance, including labor, has dropped from 0.25 in 1922-23 to 0.099 in 1931-32, while the average cost per rated-kilowatt-hour-run for repairs and renewals, including the cost of station labor, has dropped from 0.0593 in 1922-23 to 0.0408 cents as an average for the ten years. One station gets the extraordinarily low figure of 0.00378 for its three engines, which have run approximately 22,000 hours each at an average running plant load factor of about 61.2 per cent. Report is available from the Diesel Engine Users Association, 307 Abbey House, Westminster, S.W.1,



Power house, Hudson River Stone Corporation, Cold Spring, N. Y. It houses three 500-kw. generators, each driven by a 660-hp. four-cycle solid-injection diesel engine. A fourth unit will ultimately be installed

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DIESELS

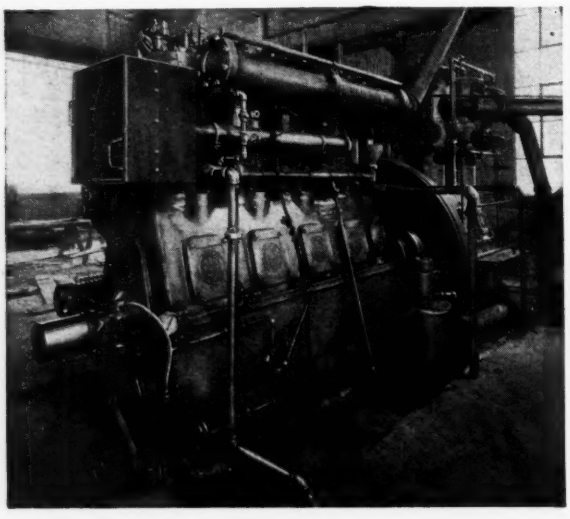
CUT POWER COSTS AT STONE PLANT

OFFICIALS of the Hudson River Stone Corporation, Cold Spring, N. Y., recently decided that erection of a private diesel-electric power plant to furnish electric current needed for operation would effect a decided saving in power costs. The cost of generating this power and supplying it through the system was computed at approximately $0.0125 per kilowatt-hour for an 8- to 10-hr. day, assuming 4c. fuel oil and including all interest, maintenance, and depreciation charges. Should conditions provide for a 14- to 16-hr. operating day, the kilowatt-hour cost would, of course, be still lower.

A prime consideration in selecting the generating units was to give greatest possible flexibility in plant operation. The units installed are three 6-cyl., four-cycle, solid-injection McIntosh & Seymour diesel engines, rated at 660 b.hp. at 300 r.p.m. Each is direct-connected to a General Electric 625-kva., 0.8 power factor generator.

The computed present load requirements are such that the three 500-kw. generator units will easily meet them. However, as soon as conditions call for full-capacity operation, a fourth 500-kw. unit will be installed. Means for taking power from the utility company's mains have been provided so that the diesel cooling-water circulating system and the lubricating-oil heaters may be started cold or from standstill. The cooling-water circulating system for the diesel engines comprises a 1,000-gal. surge tank, a 10,000-gal. cold water storage tank, a 600-g.p.m. pump operating at 45-ft. head, two 1,500 gal. hot-well tanks, and a 600-g.p.m. pump operating at 90-ft. head. The pump operating at 45-ft. head supplies cooling water to the engines and the 200-hp. Chicago Pneumatic diesel-driven air compressor. The other pump is on the "drain side" of the engines (the hot-well tanks acting as head or balancing tanks), and pumps the hot water from the diesel either through the heating coils in the main fuel-oil storage tanks and thence over the cooling tower, or, bypassing the fuel-oil tanks, directly over the cooling tower. The cycle is completed by passing the cooled water into the surge tank and thence by gravity to the 10,000-gal. storage tank. Additional equipment is:

One small gasoline engine, 350 lb. starting air compressor (non-automatic).
One motor-driven 350 lb. starting air compressor (either full automatic or normal operation at will).
One bank of fuel-oil separator equipments for each diesel engine, each comprising
  One gear pump, motor-driven.
  One 5-kw. electric heater.
  One lubricating oil separator.
Two 5-kw. oil immersion electric heaters for each diesel-engine lubricating oil tank, to permit heating the lubricating oil in cold weather before starting the engines.
One 2½-kw. oil-immersion electric heater for for each diesel-engine daily-storage fuel-oil tank, to provide for better fuel oil combustion.
One transfer pump for pumping fuel oil from the main storage tanks to the daily storage tanks in the power house.
Each fresh-air inlet of the diesel engines is provided with an American (Reed) air filter and metal louvres to permit removal of all possible dirt or foreign matter.
Three 350-lb. air-storage tanks for engine starting (one for each unit), all connected to a common manifold on both the intake and discharge sides to supply or draw air from any or all at will in accordance with the requirements.



Two hundred horsepower diesel-driven direct-current air compressor installed in power plant

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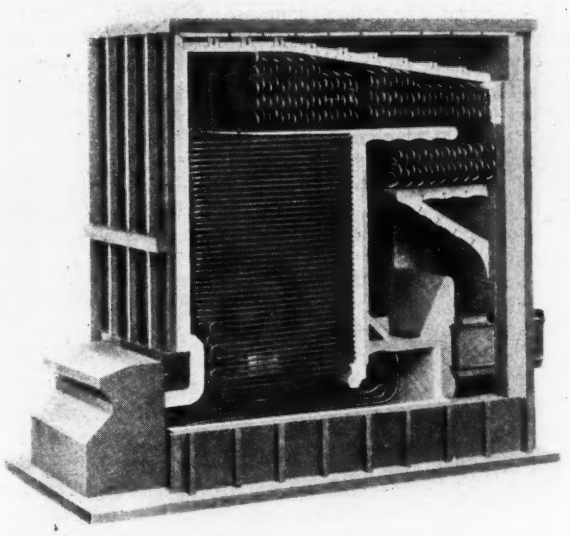
The present main fuel-oil storage system consists of three 20,000-gal. tanks, with provision for the installation of a fourth when the additional diesel unit is installed. The piping arrangement is such that the tanks may be filled from tankers, tank cars, or trucks, and by proper manipulation of valves the tanks may be drained and oil pumped out to the tankers or tank cars. In the event of fire in the power plant, all daily oil-storage tanks can be dumped into a 1,000-gal. outdoor overflow tank. All valves in the oil lines are of the Merco-Nordstrom lubricated-plug type.

ONE TUBE—1½ MILES LONG

FORMS NEW HIGH-PRESSURE BOILER



Model and tube layout in a single-tube steam generator: (*A*) Feed-Water Inlet; (*B*) Superheater Steam Outlet; (*C*), (*D*), (*E*), Coils in Contact with the Flue Gases; (*F*) Coils Heated by Radiation

EUROPEAN boiler design, in recent years, has been notable for radical departures from traditional designs. This has been particularly true in the field of high-pressure boilers, as exemplified by the Benson boiler, the Loeffler, the new Brown Boveri pressure-combustion steam generator, and others. To this rapidly expanding competition of new ideas, Sulzer Bros., Ltd., of Winterthur, Switzerland, has contributed a new type of high-pressure single-tube generator.

The following brief description is based on an article appearing in the January, 1933, *Sulzer Technical Review*.

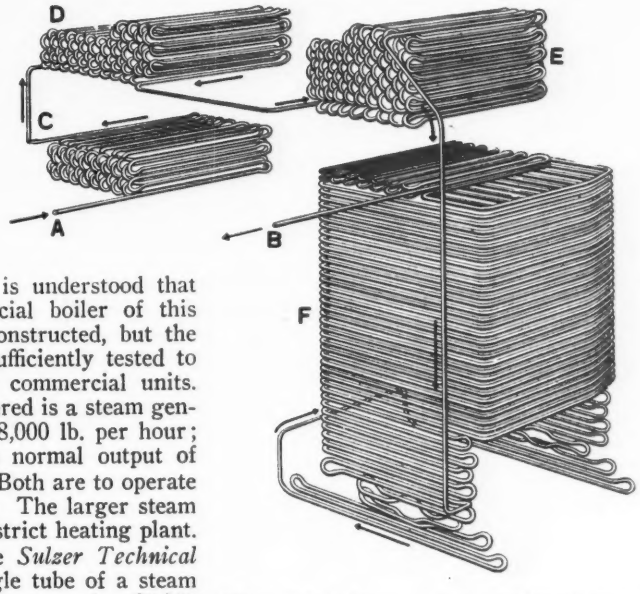
The tube arrangement is clearly shown in the open-sided model and in the tube model. It is understood that no full-size commercial boiler of this type has yet been constructed, but the principle has been sufficiently tested to result in orders for commercial units. One of the units ordered is a steam generator evaporating 18,000 lb. per hour; another will have a normal output of 40,000 lb. per hour. Both are to operate at 1,400 lb. pressure. The larger steam generator is for a district heating plant.

It is stated in the *Sulzer Technical Review* that the single tube of a steam generator capable of evaporating 20,000 lb. per hour, will have a length of 1½ miles.

Forced circulation is, of course, employed, the fluid being forced through the tube at a very high rate of speed. It is recommended that the boiler be operated with pure condensate.

Boiler drums are entirely eliminated. This likewise eliminates a large amount of heat storage available in the ordinary boiler, and makes necessary very sensitive automatic regulating devices to keep the steam pressure and temperature approximately constant.

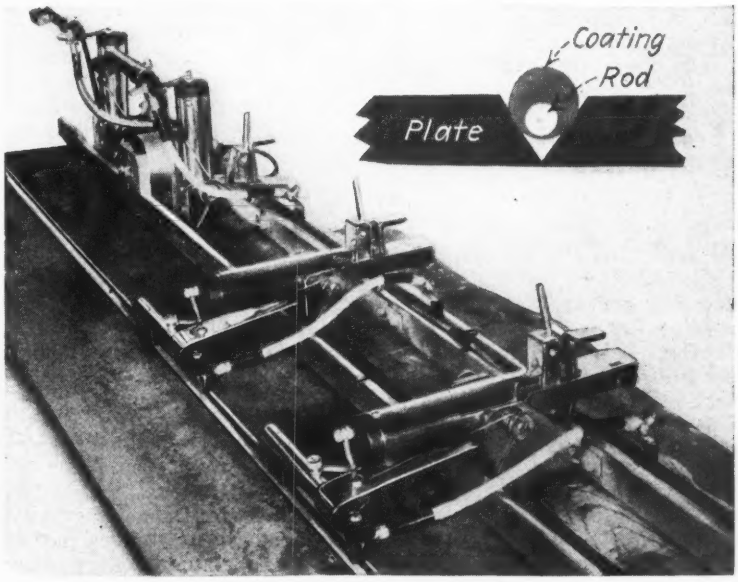
Firing is also automatically regulated.



The regulation so far employed provides for the injection of a certain amount of water at the entrance to the superheater to maintain a constant superheat temperature.

—And Now "Gun" Welding

•SHORT welds have been made by laying a rod along the line of the weld and starting the arc by shorting the rod end with a carbon pencil. This principle has been applied in the "self-consuming" automatic welding process of Champion Rivet Co., Cleveland, for welds of any length. The welding machine is simply a long, narrow table with a bus bar at one side from which contact arms extend at 16-in. intervals. A heavy welding rod with eccentric coating is placed in the V as shown, with the contacts touching the bared metal. From each contact arm there also extends a carbon pencil contacting the coating. High-frequency current is superimposed on the welding circuit to strike an arc by means of the carbons. The rod thus is fused, the eccentricity of the coating both protecting the fusion and directing it. Welds can thus be made in any position. Solenoid-operated trips lift the contact arms in succession to permit the arc to progress along the weld. Welding speed per arm is 1 ft. a minute. Tensile strengths of welds run 60,000 to 70,000 lb. per sq.in., with elongation 36 per cent in 2 in. Procedure control and constant arc length insure weld uniformity, and the simplicity of the equipment permits it to be made portable.



READERS' PROBLEMS

SODIUM SILICATE?—*The water we use for our steam plant (aggregating 5,000 sq.ft. of boilers) has a permanent hardness of 0.9 grains per gallon and temporary hardness of 1.20 g.p.g. The pH reading is 7.3. We tried to use soda ash as boiler compound, but with a concentration of 6 in the boiler we could not get hardness lower than 5.0 g.p.g. If we add more soda ash the condensate returns turn acid. We tried sodium silicate at 43.5 deg. Bé., hardness went down to 3.0 g.p.g., but condensate returns are still acid very often. Has anyone ever had the same trouble and what do they think about sodium silicate as boiler compound. Would sodium silicate mixed with soda ash solve the problem?* C. L.

[The following reply to this question was prepared by W. J. Ryan, Water Service Laboratories, Inc., New York City—Editor.]

The statement of the "temporary" and "permanent" hardness of the water does not disclose in what terms these items are expressed. Assuming that the temporary hardness of 1.2 g.p.g. is calcium bicarbonate and the 0.9 g.p.g. is calcium sulphate, the amount of soda-ash required for internal treatment is theoretically about one-eighth of a pound per thousand gallons of make-up, assuming no hardness introduced by condenser leakage, etc.

The amount of CO_2 generated in the boilers by this treatment will be small, hardly enough to render the condensate acid or corrosive unless the CO_2 keeps accumulating and building up indefinitely for lack of a deaerator or other means of getting rid of it.

However, we judge from the statements of "C.L." regarding the hardness of the boiler water that he may be having scale trouble and, in order to remedy it, may be using a large excess of soda-ash, thus getting an excessive amount of CO_2 in the steam.

If it is impossible to prevent scale without a great excess of soda-ash, trisodium phosphate should be tried, about one-half pound per thousand gallons of make-up.

Sodium silicate is not advocated for internal treatment with this water.

FUSES BLOWN WHEN ELEVATOR MOTOR IS PLUGGED—*Our elevator is driven by a 7.5-hp., 3-phase, 220-volt motor and is controlled by a mechanically operated reversing switch. Considerable trouble is being experienced because of fuses blowing. When the elevator is running in one direction the operator sometimes throws the reverse switch to the opposite position before the motor stops. What can be done to prevent this difficulty? There is no regular operator on the elevator.* F. R.

Apparently the elevator is an old one of the hand-rope operated type, and is difficult to protect against improper handling by inexperienced persons. If it is possible to do so and get satisfactory operation, the brake should be adjusted so that it will apply as soon as the reverse switch opens the circuit. This will give the maximum length of action of the brake, if the control is thrown from one running position to the other. Unless the throwover is made very suddenly the brake should bring the elevator to a stop or nearly so.

A centering rope may be connected to the operating cable. This is done by connecting the two sides of the operating rope, near the top sheave, by a piece of chain. This chain should be of a length that will allow the free movement of the operating rope. To the center of this chain a piece of hemp rope is connected, long enough to extend the length of the hoistway.

The elevator is now started in the usual way, but is stopped by pulling on the hemp rope, which will bring the two sides of the operating cable to the neutral position. If those who use the elevator can be made to stop the elevator by pulling on the hemp rope, it will insure that the control will be centered before it is thrown into reverse.

About the simplest change to make in the control, to protect against the trouble of suddenly reversing the motor, would be to connect a resistor in each of two legs of the motor circuit and install a contactor to short-circuit the resistors, the contactor being controlled by an auxiliary contact on the reversing switch. The coil on this contactor should be connected to the motor leads, between the resistor and the motor. By doing this the closing of the contactor can be delayed until the inrush current to the motor has decreased to a value that will not blow the fuses.

INCREASING THE POWER OF A STEAM-ENGINE—*How may the power of a steam engine be increased above its rated capacity?* R. T. B.

Within the safe limits of the engine's working parts there are three ways in which its power may be increased: First, by increasing the speed, in which case the safe working speed of the flywheel will probably be the limiting factor. Increasing the initial steam pressure and reducing the back pressure on the piston are other means that may be applied.

What to Do About Leaky Traps in a Gravity Heating System

Answers to the December Question

The Question

CONDENSATE from our gravity heating system returns at a temperature of about 190 deg., due to faulty operation of some of the radiator traps. Before being discharged to the sewer, the condensate flows through a heat exchanger which lowers the temperature to about 100 deg. and preheats the water before delivery to the domestic hot-water heater. As long as the temperature of the condensate discharged to the sewer is this low, will there be enough saving in steam or improvement in the operation of the heating system to justify the expense of finding and repairing the radiator traps that are out of order? C. H. R.

Return Temperature Does Not Indicate Leaky Trap

RADIATOR traps for gravity steam systems are usually designed to operate at a temperature slightly below that of atmospheric steam. A condensate return temperature of 190 deg. F., therefore, does not indicate any leaking traps. No concern need be felt regarding the proper functioning of these traps unless the return temperature runs consistently between 200 and 210 deg. F., depending somewhat upon how close to the last radiator it is measured and whether or not the return lines are insulated.

If economy of operation is the end desired, it would seem that there are other places to look than to the radiator traps, which are apparently in good condition. Quite an increase in useful work is obtained by the use of a heat exchanger for preheating domestic hot water. However, a further increase of better than 4½ per cent can be obtained by returning all condensate to the boilers instead of running it to the sewer. Such an increase would reflect directly upon the fuel consumption. There are a number of gravity condensate return traps on the market which operate satisfactorily and for economical operation. Such an installation should be made.

No mention has been made of the cost

of water, but surely an additional appreciable saving would be made by thus eliminating the necessity for 100 per cent boiler make-up. Any abnormal raw water condition which might result in increased boiler and pipe line maintenance costs should also be considered in determining the total saving to be obtained by thus returning the condensate to the boilers instead of wasting it.

Lancaster, Pa. P. H. YEOMANS.

Return Temperature Not Too High

THE temperature of 190 deg. of the condensate return from the heating system does not seem unduly high for a system working at or slightly above atmospheric pressure, nor does the discharge temperature to the sewer seem excessive. It is doubtful if any noticeable saving could be achieved by repairing the faulty traps. However, each degree the final temperature is lowered means a saving of one B.t.u. per lb. Naturally, if the condensate temperature is lowered by repairing the traps the final temperature will also fall.

Such savings figured over a short period sometimes appear very small, but taken over an entire heating season will no doubt prove to be worthwhile.

Aside from all this, by all the rules of good house-keeping the traps should be repaired, as each trap represents an investment and the only way a fair return can be realized on such investments is to keep the equipment involved in good working order.

Such work should be included with the regular maintenance and not let go until a general overhauling is necessary.

RAYMOND SEPTOR.

South Amboy, N. J.

Leaky Trap Interferes With Operation of Heating System

THE expense of keeping radiator traps in repair can always be justified. In well-maintained buildings all of the radiator and drip traps are overhauled every summer, with the result that there is little difficulty with leaky traps during the heating season. Traps which are out of order allow steam to blow through into the return system where the heat is often wasted by being given off to parts of the building which do not need heat.

Another reason for not allowing steam to blow through traps into the return system is that it interferes with the flow of condensate. Often the steam from leaky radiator traps holds back the condensate from other radiators, with the result that some radiators are difficult to heat. In buildings which have leaky radiator traps, some radiators may not get hot enough properly to heat the rooms in severe weather. Fix the traps and give the radiators a chance to discharge the air and condensate properly so the radiators can fill with steam and the trouble will disappear. This work can usually be done by the regular maintenance men during spare time in the summer; the only extra expense is that for parts.

If by fixing the traps the temperature of the condensate leaving the heat exchanger is lowered from 100 deg. to say 80 deg., a saving of 20 B.t.u. per lb. of steam is made, or about 1.8 per cent. Assuming that a building uses 10,000,000 lb. of steam per year and pays $1 per 1,000 lb. for steam, a saving of 1.8 per cent would amount to $180 per year. The actual saving, however, due to improved operation of the heating system, probably would be much greater than this.

With the heating system working properly the heating-up time in the morning can be reduced, and thus steam need not be turned on so early. Waste of steam to the return piping is eliminated and the hours of operation per day shortened. Also, if the control of building temperature is by turning steam on intermittently during the day, it will be found that the length of the intervals when steam is on can be reduced because of the more rapid and uniform heating of the building. There are cases on record where savings of as much as 20 per cent have followed repairs to traps.

STERLING S. SANFORD,
Sales Engineer, The Detroit Edison Co.
Detroit, Mich.

A Question for Our Readers

I HAVE several induction motors of the squirrel-cage and wound-rotor types, ranging in size from 50 to 150 hp. There is available a spare compensator of sufficient capacity to start the largest motor. In case of a failure of the starting equipment on one of the wound-rotor motors could its slip rings be short-circuited and the motor started with the spare compensator? If Power *readers have had experience with starting wound-rotor motors in that way I would appreciate knowing how successful it was.* B. E.

Suitable answers from readers will be paid for if space is avaliable for their publication.

Condensate Should Be Returned to Boiler

IT WOULD be hard to say just what the saving would be if the heating system is put in proper working order, without knowing more of the local conditions. Is the steam generated in this plant or bought from a central heating plant? It is not a question of whether the repairs should be made now or later when conditions get so bad that it is necessary to spend double the amount to get the system to work properly.

If the steam is generated in this plant I would not let the condensation go to the sewer, as the scale-forming material has all been removed and when used in the boiler practically eliminates scale formation, lengthens the boiler washing period and cuts down the fuel consumption.

A blowing or leaking trap in a heating system has a tendency to throw the entire system out of balance. Steam will follow the path of least resistance, robbing the properly trapped radiators of their steam. It will create sufficient back pressure in the common return to make the traps sluggish and cause some sections of the heating system to be much cooler than others.

My experience has been that it never pays to put off until tomorrow what can be done today, and this is very true in power plant maintenance as the little things that are not given attention at the proper time will accumulate until you have the fact staring you in the face that the job is working you instead of you working the job.

W. H. PENDERGRASS, SR.

Decatur, Ga.

Good House-Keeping Requires Trap Repair

AFTER reading the problem of C.H.R. I immediately thought of the first paragraph in the answer submitted by H. W. Stalnaker to the October problem. I mean where he says about the "employment of person or persons incapable of holding up their end of the job."

One does not have to be a close observer to see that in many plants the engineer is as little thought of as the office cat, if there is one. The reason is that a too short apprenticeship, a too sketchy technical education or an inability to move with the times has lost him the respect of plant managers.

To any engineer who is worth his salt the mere thought that any part of his equipment is out of order for any considerable period would be anathema. He would not rest easily in his bed at night if he knew that any part of his domain were not functioning efficiently. In this case the 190-deg. returns show plainly there is a trap out of order. The repair of a trap is so small a matter that it should be undertaken immediately. The fact that this return is made use of in a heat exchanger only begs the question.

I would certainly advise the immediate repair of any faulty trap and, when it is found that the heat exchanger does less work than before in the way of preheating I would use a little more direct steam for this purpose and, at least, have the satisfaction of knowing that my plant was efficient and my standards not deteriorating.

Trenton, N. J. MARCUS BELL.

THE ENGINEER'S BOOKSHELF

Electrical Handbook

STANDARD HANDBOOK FOR ELECTRICAL ENGINEERS (*Sixth Edition*). *Frank F. Fowle, Editor-in-Chief. Published by McGraw-Hill Book Co., Inc., New York City. 1933. Flexible binding; size 5x7 in.; numerous tables; illustrated; 2,816 pages. Price $7.*

This edition is approximately thirty per cent larger than the fifth, which contained 2,137 pages. In terms of new subject matter it is more than three-quarters a new book, while the number of contributors has increased from 61 to 91. In the preparation of the new edition the same editorial policy and presentation of material has been followed as in the previous edition.

The number of sections has been increased from 25 to 28. The important changes in section headings include steam, gas and oil prime movers, hydraulic prime movers, power-plant electrical equipment, electric heating applications, radio and carrier communications, and electron tubes and electric wave filters. Many of the other sections have been greatly enlarged by rewriting them and adding new articles to bring the book into accordance with the latest electrical engineering practice.

Heat Transmission

HEAT TRANSMISSION. *By William H. McAdams, professor of chemical engineering Massachusetts Institute of Technology. Published by McGraw-Hill Book Co., 330 West 42nd St., New York City, 1932. Cloth, 6x9 in.; 383 pages; 135 illustration; 15 tables. Price $5.*

Sponsored by the Committee on Heat Transmission of the National Research Council, this book is supposed to serve both as a text for students and as a reference for practicing engineers. It deals with the problem of heat transmission from basic principles. Much of the material, collected from a variety of sources and reduced to a common basis, is presented in graphical and tabular form in order to make it more generally useful. Alignment charts are used in the solution of some equations, and illustrative problems are given for all.

The book actually comprises three parts, conduction, radiation and convection. The first, composed of two chapters, deals with steady conduction, unsteady conduction, thermal conductivities, effect of shape of body, resistances in series and in parallel, etc. The second section treats radiation between solids, from non-luminous and luminous flames, and the general problem of furnace design. The third, composed of seven chapters, deals with dimensional solidarity, fluid dynamics, relation between individual and over-all coefficients of heat transfer, effect of scale deposits, heat exchangers, measurement of surface temperatures, fluids inside and outside pipes, condensation and evaporation. The appendix includes a number of valuable tables and charts and a bibliography which also serves as an author index.

What Is Technocracy?

"WHAT IS TECHNOCRACY?"—*By Allen Raymond, staff writer on the New York Herald Tribune. 180 pages, 5x8 in. Published by Whittlesey House, a division of the McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. Price $1.50.*

It is at once apparent that Mr. Raymond has done a careful and considered reporting job. The result is a book which gives the layman an opportunity to examine Technocracy from many angles, paraphrased in such fashion as to make the subject generally intelligible. Technocracy appears as a most amazing and fascinating subject—a mad mixture of fact and fancy, of reason and error, so closely intertwined and so often indiscriminately yet intimately associated that it is difficult to separate the wheat from the chaff! At the moment the "labor of the mountain" seems to prove only "that a little knowledge is a dangerous thing."

If this be Technocracy—and Mr. Raymond maintains that it is—it is a theorem that must be rejected at this time because of a multiplicity of errors of facts, interpretation and unsupported prophesy. When one is asked to subscribe to and endorse a fundamental philosophy, more is expected of its leaders than bad arithmetic and the interpretation of fallacies as truth.

Many, if not all, of the truths that are sometimes so roughly handled have been well known to our scientists, economists, sociologists and philosophers, and today are serving as an orderly and organized part of their individual approaches to the solution of the many problems of our times. What Mr. Scott and his associates have wrought resembles strongly the patter and prattle that might be overheard at a "bier bund" of a group of sophomores in mechanical engineering, sociology, political economy, economics, medicine and the related sciences—all from a few facts mixed with the yeast of unrestrained enthusiasm. Carefully avoiding direct statement, the powers of inference are abused to create the impression of the founding of a new order.

If Technocracy is to continue as a clinical observation post it needs new direction and to be set upon a true course that will improve its chances of arriving at some destination. It is regrettable that something more worthy was not afforded the opportunity for popular examination and exploitation given Technocracy by the recent tidal wave of publicity.

To all business man and industrialists the investment of the time and money required to read this book will be well repaid if in no other way than by indicating the proper disposal of another "ism."

Vibration

VIBRATION PREVENTION IN ENGINEERING. *By Arthur L. Kimball. Published by John Wiley & Sons, Inc., New York City, 1932. Cloth; 6x9 in.; 82 illustrations; 145 pages. Price $2.50.*

High-speed machinery and the installation of these machines in public buildings and in other locations where noise is objectionable has made vibration an outstanding problem in modern engineering. In this book there is given a resumé of the various aspects of vibration prevention in engineering. It is intended as a reference for practicing engineers and for students in taking advanced engineering courses.

Some of the subjects covered are vibration of loaded cantilevers, simple torsional vibration, vibration of rods, critical speeds of rotors, turbine-wheel vibration, balance of rigid rotors, prevention of noise, theory of vibration damping, shaft whirling and vibration damping in turbine buckets. The book is largely a mathematical treatment, but long analytical developments not essential to an understanding of each problem have been avoided. The scope of the work comprises material necessary for handling effectively any unusual vibration problem and should find a wide field of usefulness among those qualified.

Brief Reviews

CATALYTIC OXIDATION OF ORGANIC COMPOUNDS IN THE VAPOR PHASE (1932). By L. F. Marek, acting director of the research laboratory of Applied Chemistry, Massachusetts Institute of Technology, and Dorothy A. Hahn, professor of organic chemistry, Mt. Holyoke College. 486 pages, 6x8 in. Indexed. 60 illustrations. Cloth-board covers. Published by the Chemical Catalog Co., 419 Fourth Ave., New York, N. Y. No. 61 of the Monograph Series of the American Chemical Society. Price $9. —Power engineers will be particularly interested in these chapters: "Oxidation of Petroleum Oils," "Surface Combustion," "Cause and Suppression of Knocking in Internal Combustion Engines." This is of course a theoretical treatment, but in language that is readily understandable and straightforward. It brings together, for the first time, the data on these subjects and summarizes them.

ECONOMIC TENDENCIES — The National Bureau of Economic Research, 51 Madison Ave., New York City, has issued a report, "Economic Tendencies in the United States: Aspects Pre-War and Post-War Changes," by Frederick C. Mills. 630 pp., 213 tables, 108 charts. Price, $5.

FEDERAL POWER COMMISSION—The 12th Annual Report of the Federal Power Commission and the Federal Power Commission Laws have been printed by the United States Government Printing Office. Copies are available from the Superintendent of Documents, Washington, D. C.

MUNICIPAL LIGHTING PLANTS—This record of 222 cities under municipal ownership rates in effect during 1932, by C. F. Lambert, has been published by Burns & McDonnell Engineering Co., 406 Interstate Building, Kansas City, Mo. Price $1.

MECHANICAL WORLD YEAR BOOK—Considerable information on high-speed gasoline engines and the introduction and increasing use of the diesel is included in a new section on internal combustion engines. Another comprehensive section discusses bucket elevators. Copies from Emmott & Co., Ltd., 31 King St., West Manchester, England. Price 1/6 net.

MARKET GUIDE—"Manufacturing Market Statistics" is a compilation of basic marketing data, including a plant-location section showing for the first time, on the basis of the 1929 Census of Manufactures, the location by state and county of more than 200,000 manufacturing concerns, classed in 326 primary industry groups. Available from the Government Printing Office, Washington, D. C., or from district offices of the Bureau of Foreign and Domestic Commerce. Price $1.

BUREAU OF MINES—Included in new publications of the Bureau of Mines are, "Deviation of Natural Gas from Boyle's Law," by T. W. Johnson and W. B. Berwald. 29 pp. 7 illus. Five cents. "Carbonizing Properties and Constitution of Chilton Bed Coal from Boone No. 2 Mine, Logan County, W. Va.," by A. C. Fieldner and collaborators. 60 pp. 34 illus. 10 cents. Available from Superintendent of Documents, Washington.

SMOKE—The Government of Bengal has issued the Twenty-sixth Annual Report of the Bengal Smoke Nuisances Commission for the year 1931. It is available from the Bengal Secretariat Book Depot in Calcutta for 2 annas, Indian, or 3d, English.

CHEAP BOILERS AND CHEAP STEAM (Billige Kessel, Billiger Dampf). Progress in Development and Operation of Power Boilers, by Dipl.-Ing. Ernst Praetorius. First of the series of engineer training courses. 171 pages with 43 illustrations. Published by Verkehrswissenschaftliche Lehrmittelgesellschaft m.b.h. bei der Deutschen Reichsbahn, Berlin W9, Vosstrasse 6, in cooperation with VDI—Verlag. Price 3.5 Reichsmarks.

ENGINEERING—A CAREER—A CULTURE—This pamphlet is prepared by the Education Research Committee of the Engineering Foundation with active co-operation of groups in six national engineering societies. Addressed to young men and to parents and teachers, it clarifies for youths the broad field of engineering. Copies obtainable from the Foundation at the Engineering Societies Building, New York. In lots of 50 or multiples of 50, $10 a hundred. Single copies and lots less than 50, 15 cents a copy.

FUELS DATA—Educational Bulletin No. 6, of the Committee of Ten—Coal and Heating Industries of Chicago, discusses, "Comparative Data on Solid, Liquid and Gaseous Fuels," largely adaptations and interpretations of information contained in previous bulletins of the series. Most of the material is in tabular form. 25 mimeographed pages. Committee of Ten—Coal and Heating Industries, 1715 Bell Building, 307 N. Michigan Ave., Chicago, Ill. Price, 20 cents a copy. Special prices for quantities.

COKE OVEN GAS—The Institute of Fuel has issued a paper, "The Production of Organic Compounds from Coke Oven Gas," by J. W. Osterrieth and Dr. George Dechamps, presented Jan. 11. Another paper, presented Dec. 9, is, "The Theory and Practice of Gasification and Combustion," by H. L. Pirie. Both are available from the Secretary, The Institute of Fuel, 53 Victoria St., London, S. W. 1, England.

BOILER OPERATION—American Boiler Manufacturers Association, 709 Rockefeller Bldg., Cleveland, Ohio, has issued a boiler room card, "Suggested Rules for Care and operation of Power Boilers," suitable for posting.

ELECTRON-TYPE RECTIFIERS

Featured at A.I.E.E. Winter Convention

At six of fourteen technical sessions, papers were presented dealing with various phases of electron-tube applications, one indication of how rapidly these devices are coming into power-supply and application work

CONFIDENCE in the future was exemplified in the size and scope of the winter-convention program of the American Institute of Electrical Engineers in New York City, Jan. 23-27. A wide variety of scientific and engineering subjects were presented and discussed in 61 papers at 14 technical sessions. The papers included such subjects as recent developments in high-current mercury-arc and other electronic-type rectifiers, the future development of high-pressure steam plants, automatic control of pumping stations, selection of supervisory control, parallel operation of alternating-current generators, protection of electrical apparatus, and other subjects of interest to electrical and operating engineers.

Attention was directed to the possible application of condenser discharge circuits in connection with an electronic-type impulse relay for quick response excitation and for automatic synchronizers, by F. H. Gulliksen in a paper, "The Principle of Condenser Discharge Applied to Central Station Control Problems."

Grid-Controlled Rectifier

A 3,000-kw., 600-volt, single-unit, grid-controlled mercury-arc rectifier was discussed in a paper by E. H. Reid and C. C. Herskind. An important characteristic of this rectifier unit is its operating temperature, materially higher than any heretofore used in general practice. Tests show that, up to a certain temperature arc drop is reduced as temperature is increased. This indicates that maximum efficiency is obtained by operating at temperatures giving the lowest arc drop. Among other advantages of high-operating temperature is increased cooling efficiency.

A synchronous commutator of the short-circuiting type, modified to enable it to perform the two functions of rectification and inversion interchangeably under conditions of comparatively high voltage and current, was the subject of a paper, "Synchronous Mechanical Rectifier Inverter," by S. S. Seyfert. Oscillograph records show that the experimental rectifier, embodying the features outlined, passes from full-load rectifying to full-load inverting in response to a sudden change of direct-current system voltage with perfect commutation in every cycle during the transition.

A paper, "Recent Developments in Electronic Devices for Industrial Control," by F. H. Gulliksen, described electronic equipment for control of direct-current motors operated from alternating-current sources. The alternating-current voltage is rectified by means of power-glow tubes and applied to the armature of the motor. Voltage applied to the motor armature is regulated by means of phase shift control of the glow-tube-grid voltage.

Inverters and Rectifiers

Rectifiers and inverters employing grid controlled gas- or vapor-filled electronic valves require some means of interrupting the current through the tube. "Commutation" is the term applied to interrupting of this circuit. In a paper, "Harmonic Commutator for Thyratron Inverters and Rectifiers," by C. H. Willis, the problem of commutation was discussed and a method of using a harmonic circuit of reduced kilovolt-amperes to forced commutation was described. By the aid of harmonic commutation, inverters can be operated to supply lagging loads, and rectifiers can be phase controlled in the leading quadrant. A rectifier which is phase controlled 90 deg. leading becomes equivalent to a synchronous condenser, and may be used for power-factor correction.

The Relay Sub-Committee of the American Institute of Electrical Engineers' Protected Devices Committee submitted recommendations for the protection of electrical apparatus, based upon a questionnaire, and the 37 replies thereto, from specialists in that field.

Direct-Selection of Supervisory Control

"Principles of Direct-Selection System of Supervisory Control" was the title of a paper by M. E. Reagan. Direct selection is the term applied to a system of supervisory control introduced in 1932. Its outstanding characteristic is high speed, since it selects any one of a number of remote units without requiring sequence stepping or counting chains. The direct selection system has been developed to control more than 50 units over 4-line wires, or 25 units over 2-line wires.

Self-exciting alternating-current commutator generators have been considered for some time as sources of electric power. However, what is probably the first commercial use of this type of generator as the prime source of energy for a power machine, has recently been made and was the subject of a paper, "Low Frequency Self-Exciting Commutator Generator," by J. I. Hull. It is a six-pole, 1,200-r.p.m., three-phase machine rated at 40 kva., 235 volts, 2.5 cycles, and is driven by a squirrel-cage induction motor.

M. Stone, in a paper, "Parallel Operation of Alternating-Current Generators—Action of Governors and Damper Windings," described an investigation of future questions of stability of alternating-current generators operating in parallel when load is suddenly thrown off or on the system. The analysis shows that a governor-controlled prime mover driving synchronous generators operating in parallel constitutes a coupled oscillatory system of an unusual nature. The coupling is such that under certain relations of the natural periods of the two oscillatory systems, and for restricted values of governor friction and damper-winding resistance, a disturbance such as a load shock may result in load pulsations of increasing amplitude.

High Steam Pressures

A résumé of the accomplishments to date, in the long-continued movement toward ever-improved operating economy in steam-electric generating stations was given in a paper, "High Steam Pressures and Temperatures a Challenge to Engineers," by Melvin D. Engle and Irving E. Moultrop. From a consideration of the facts presented in the paper, the authors draw the conclusion that the engineers of the future will meet the challenge of past accomplishments, will use still higher steam pressures and temperatures and will build steam-electric generating stations of better fuel economy and lower cost. A comprehensive abstract of this paper will be published in the March number.

The application of electric motors and control equipment to pipe-line pumping stations was described in a paper, "Pipe-Line Pumping and Automatic Control," by John Fies. Experience already obtained with electric drive and automatic control of pipe-line pumping stations allows the conclusions that the pumping of crude oil and gasoline through pipe lines is an industry which is growing rapidly and is becoming an important customer of both electric utilities and manufacturers; and that electric motor drive for pipe-line pumping is in competition with internal-combustion and steam engines.

A.S.H.V.E. DISCUSSES OPERATION—DESIGN—RESEARCH

PAPERS presented at the 39th annual meeting of the American Society of Heating & Ventilating Engineers, Jan. 23-25 at Cincinnati, may be classified under three general headings: operation, design, and research.

One operating paper called attention for the first time to the problem of corrosion in air-conditioning equipment. The author, R. M. Palmer, presented an analysis of water both before and after use in air washing. Free CO_2 increased from 6 to 54.8 p.p.m., total solids from 40 to 217 p.p.m., calcium sulphate from 13 to 132 p.p.m. and the pH value decreased from 6.9 to 4.8. It is readily seen that the use of this water in the air washer has changed it to a distinctly acid water with highly corrosive properties. This change was brought about by absorption by the water of CO_2, sulphur oxides and solids from the large volume of air passing through the washer.

Water Treatment

The corrosive nature of the water may be corrected by proper chemical treatment. The author said, however, that the wide variety of waters used for air conditioning does not permit a detailed recommendation for treatment. In general, pH values of 8.0 to 9.0 should be maintained and the alkalinity should form a protective film that will not interfere with heat transfer rates.

Discussion brought an inquiry on the effect of chromates in preventing corrosion. Mr. Palmer pointed to the toxic effect of chromates, which he felt made them dangerous to use.

To determine the magnitude of the effect of cold walls on comfort temperature, a study was undertaken at the A.S.H.V.E. laboratories and the results were reported by F. C. Houghten. It was found that the increased radiation of heat from occupants in a room to cold walls on three sides requires a higher air temperature for the same feeling of comfort.

In discussion of the paper it was disclosed that an inside wall temperature of 55 deg. was not unusual with 0 deg. outside temperature and that the effect of cold walls on comfort was more important than the possible variation in relative humidity. With an appreciable glass area in the walls the cold wall effect is aggravated.

Another operating paper by L. E. Seeley, J. H. Powers and E. J. Tavanlar, presented by title, dealt with the effect of air supply on the performance of oil burners. The characteristics of four types of burners with respect to air supply were studied and compared.

Two most important design papers were presented jointly by J. L. Blackshaw. These were comparison papers, one dealing with condensate and air return in heating systems and the other with the flow of air and condensate in 1½- and 2-in. steam heating returns.

The first reports for the first time data taken on an actual heating system, showing the quantity and ratio of condensate and air in heating system returns during the heating-up period. Both studies were undertaken to obtain data that would permit extending the return-pipe size capacity tables of the A.S.H.V.E. Guide to include 1½- and 2-in. returns.

One study was made on a two-pipe gravity vapor system in a 12-room residence containing 640 sq.ft. of direct radiation; the other on that part of the vacuum pump differential system in the Grant Building, Pittsburgh, on the 34th to the 39th floors, which contained 2,510 sq.ft. of concealed, extended-surface copper radiation.

A striking fact found, concerning the condensation return and the air elimination return, is the short time required for the elimination of most of the air from the system. In all cases the maximum rate of air elimination comes much earlier than the maximum rate of condensation return. In fact, in all cases the air elimination rate has reached its maximum and receded to a much lower rate during the first five minutes, measured from the time steam is turned on to the system. Condensation return, however, rarely approaches its maximum rate until nine to nineteen minutes after operation has started. This is a most significant fact bearing on the needed capacity of the return for carrying condensation air during the heating-up period, for if the air elimination maximum were coincident with the condensation return maximum the load on the system at this time would be greater, and larger pipes would be required.

The maximum rate of condensation never reached more than 143 per cent of the designed condensation load, and in the system with copper radiation the air condensation ratio at the time of maximum load never exceeded 0.05 cu.ft. of air per lb. of condensate when the system operated at or above atmospheric pressure or when there was no leakage.

The maximum condensation rate in pounds per hour was found to increase nearly directly as the pressure drop through the system increased. It was also found that the air leakage in cubic feet per hour decreased as the absolute pressure in the return line increased.

It is recommended that return pipe sizes for vacuum systems be based on a maximum condensation load during the heating-up period of 150 per cent of the designed condensation load under standard conditions, and a ratio of 0.10 cu.ft. of air per lb. of condensate, allowing possibly a slightly smaller ratio of air for systems containing radiation with small volumetric capacities, and a slightly higher ratio for systems containing radiation with large volumetric capacity. Return pipe sizes in gravity systems should allow a larger factor of safety, and hence it was recommended that they be based on 175 per cent of the designed condensation load under standard conditions and a ratio of 0.15 cu.ft. of air per lb. of condensate.

From the results of flow tests made to determine the capacity of return lines of 1½-in. and 2-in. diameter, with varying ratios of air to water, an equation was developed that relates the condensation load in lb. per hr., the pressure drop in oz. per 100 ft., the ratio of cu.ft. of air per lb. of condensate, and the actual internal pipe diameter. It is:

$$L = (2.18P^{.9482} - P^{.3680^3} \log R) \times (157.08d^3 + 80) - 500$$

where

L = condensation load in lb. per hr.
P = pressure drop in oz. per 100 ft.
R = ratio—cu.ft. of air per lb. of condensate.
d = actual internal diameter of pipe in in.

Charts are given in the paper in which the pressure drop flow relation is shown for different ratios of air and water flowing in 1-in., 1½-in. and 2-in. pipes when operating as a dry return main.

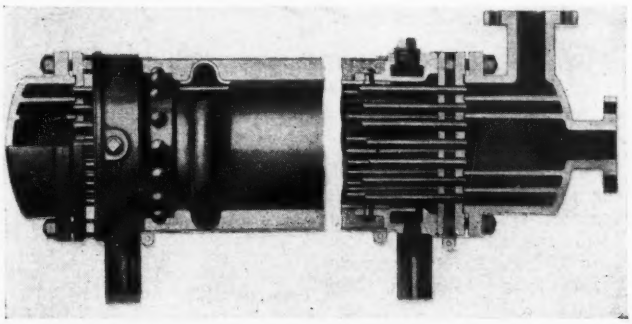
Leakage of air into piping systems under vacuum varies widely with different set-up studies, becoming greater as the number of fittings and valves around radiator connections increase. The total leakage, however, even with vacuums applied uniformly throughout the system larger than customarily used in practice, corresponds to comparatively small rates of flow during normal operation of the system.

James Govan presented data concerning the heating of several buildings in Canada. One of them was an insulated shed in which no heating plant had been installed. Indoor and outdoor temperatures were recorded for a considerable period, and though the outdoor temperature dropped to or below zero on fourteen occasions the indoor temperature was as low as 30 deg. F. on only six occasions.

A paper of importance to the research laboratory, presented by A. P. Kratz, gave results of studies made to show how thermocouples should be applied to measure wall surface temperatures. By using copper-constantan thermocouples of No. 34 wire embedded in a scratch in the surface and covered with plaster, practically no correction was required to obtain true surface temperature.

Officers of the Society elected for the year were: president, W. T. Jones; first vice-president, C. V. Haynes; second vice-president, John Howatt; treasurer, D. S. Boyden; members of the council (3-yr. term) R. H. Carpenter, J. D. Cassell, F. C. McIntosh, L. Walter Moon.

WHAT'S NEW IN PLANT EQUIPMENT



8-Pass, Tubular, Outside-Joint Oil Heater

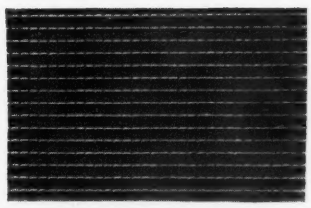
Coen outside-joint oil heater avoids possibility of a leaky tube joint permitting oil to enter steam space and thus get into the boiler, hot well or cooling tower. Tube sheets are rolled steel, two tube sheets at each end, with space between them open to air. Expansion joint built into shell relieves expansion strains. Cold oil goes through center tubes and is gradually heated as it approaches outer row nearest casing which is at steam temperature. Steam enters cored annular passage at either end of shell. From this passage it is distributed into heater shell through a row of holes on inner circumference. Steam connection at either end of heater and drain connections at four points, two at each end. Heater may be used as cooler by reversing oil flow and circulating cold water through steam space.

Coen Co., Los Angeles, Calif.

Flexible Coupling

Composed of only three parts, the center member of this coupling is of non-metallic material, self-lubricated by means of a reservoir within it. Floating center member slides between the jaws of one metal flange on a line passing through the center. It is free to slide across the face of the second flange in a direction at right angles to the first. Flanges are of nickel iron of high tensile strength.

D. O. James Manufacturing Co., 1114 W. Monroe St., Chicago, Ill.



Tread-Surface Leather Belt

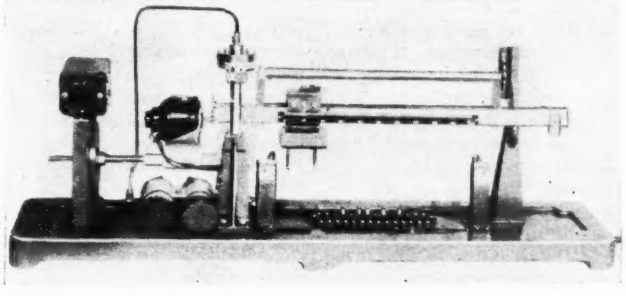
"Vim-Tred" belt has a non-skid surface produced by pressing down or indenting part of belt surface. This is claimed to concentrate pressure between belt and pulley on ribbed tread and consequently increase gripping power of belt.

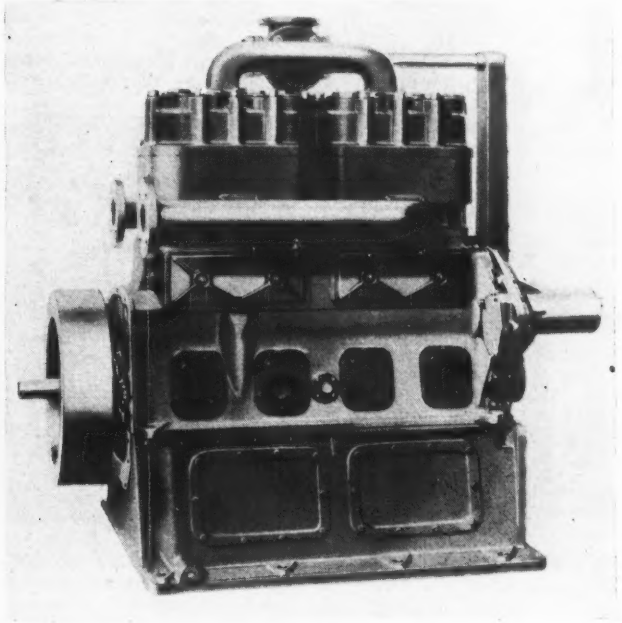
E. F. Houghton & Co., 240 W. Somerset St., Philadelphia.

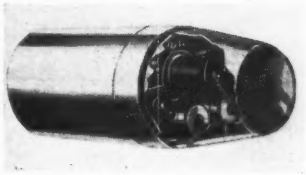
Beam-Type Pressure Transmitter

This pressure transmitter consists of a scale beam about 20 in. long, which balances on a knife edge. On the beam is a motor-driven screw which moves a weight toward or away from knife-edge fulcrum to keep beam in balance. This is accomplished through two control contacts mounted above and below end of beam. As beam rises or falls from balanced position, contact is made and motor operates to move weight to balance beam. A scale mounted on beam below moving weight reads known pressure in lb. per sq.in. Electrical contact on weight records position of weight as a measure of pressure, by controlling position of pen on pressure recorder.

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.







Radiation Pyrometer

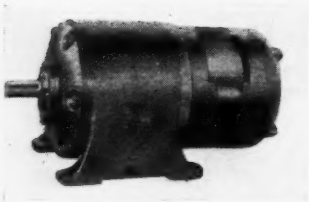
Illustrated is radiation tube of "Pyro" pyrometer, a compact, self-contained unit with all parts inclosed in dust and moisture-proof chromium-plated, metal housing. Thermocouple bulb develops energy by having focused on it, through a quartz lens, radiant heat and light rays from body to be measured. It can be used with almost any standard type of indicator or recorder. Standard tubes develop 12 millivolts with a time lag of 12 sec., in ranges from 1,300-2,200 deg. F., to 1,800-3,600 deg. F. Super-sensitive radiation tubes are in two types: *A* which develops 20 millivolts starting at 750-1,500 deg. F., and up to 1,800-3,600 deg. F., and *B* developing 60 millivolts with time lag of approximately 2 sec., in ranges from 1,400-2,400 deg. F., to 1,600-3,600 deg. F. High e.m.f. of 60 mv. has made it possible to record, in conjunction with the company's rapid recorder, rapidly changing temperatures and those of moving objects within or outside furnace. Where super-sensitive radiation tube is subjected to excessive heat, a cast-aluminum, water-cooled jacket is provided.

Pyrometer Instrument Co., 103-105 Lafayette St., New York, N. Y.

High-Speed Multi-Cylinder Steam Engine

Type S4-1002 Hayden-Davis single-acting steam engine, weighing about 24 lb. per horsepower and occupying 15 sq.ft. (100-hp. size), operates under loads varying from 50 to 150 hp. at 600 to 1,200 r.p.m. Can be used economically in condensing and in high back-pressure conditions. Four 6¾x7-in. cylinders in line. Cam and spring-actuated poppet valves control steam admission, cutoff, exhaust and compression. Main exhaust occurs at end of downward stroke through fixed unvalved ports, 6-ring trunk pistons uncovering ports at end of working stroke and covering them during all other cylinder events. Camshafts of various designs provide different engine characteristics. At 900 r.p.m. piston travel is only 1,050 f.p.m., which avoids causes of oscillation and vibration, and need for a heavy flywheel, shaft, journal and base. A full-pressure circulating lubrication system is used, and the engine is completely inclosed. Starting, stopping and speed control provided. Reverse at full speed incorporated. Engine will start heavy loads without intervening clutch or other disengaging aid. Valve mechanism accessible by removal of side plate. Bronze-backed babbitt bearings, heat-treated connecting rods, alloy valves. Piston displacement 1,002 cu.in. Permissible steam pressure, 100 to 250 lb. per sq.in. Approximate weight, 2,300 lb. Built by Waukesha Motor Co.

Hayden-Davis Engine Co., Inc., Waukesha, Wis.



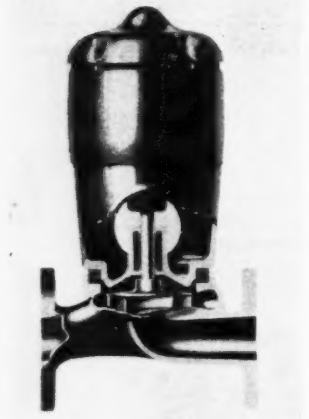
Motor Reduction Unit

A standard round-frame type motor is mounted directly on gear reducer housing to form this compact unit. Helical gears are used. Standard speeds at power take-off are from 3.02 r.p.m. to 380 r.p.m., but lower speeds can be provided; 6.08 r.p.m. is obtained with a 1750-r.p.m. motor. Bearings supporting gear drives are ball or roller type. Lubrication is automatic and continuous. Standard units for floor mounting, but others available. Any type motor.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Hot-Water Heating System

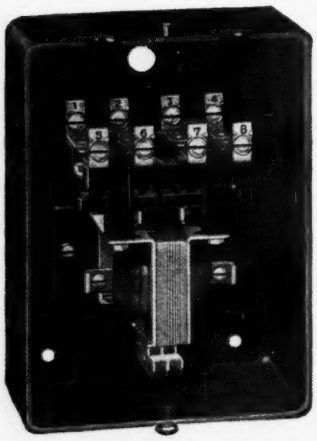
"Force-Flo" one-pipe system for hot water heating. Water mechanically circulated by pump illustrated. Claimed to give three to five times more efficiency than similar pumps at equivalent cost. Centrifugal type capable of operating against considerable friction head. Pump motor of condenser type with stainless steel shaft, and rotary seal instead of stuffing box. Can be used to modernize present installations.



The Stevens-Root Co., 51 E. Grand Ave., Chicago, Ill.

Solenoid-Operated Contactors

Bulletin 700 solenoid-operated a.c. contactors available with or without inclosing cabinets are in single or multiple pole construction with silver-to-silver contacts up to and including an 8-pole unit for 2-wire control. Compact, and since contacts are supported on self-contained insulating cross pieces, contactors can be mounted directly on metal panels or machines. Operating coils can be furnished for any frequency in voltage—6, 12, 24, 110 and 220 being standard. Furnished with standard 2- and 3-wire control and built-in transformers for

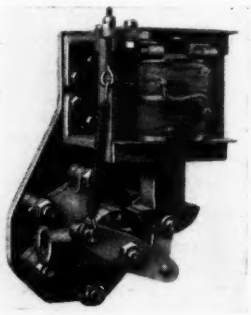


lowering voltage of control circuit. Other models arranged with resistors for thermostat control, and a special line of mechanically - held contactors also available in which no current flows through contactor coils except during moment when contactor is being closed or opened. Ratings from 5 to 30 amp., depending upon type and voltage of application.

Allen-Bradley Co., 1311 S. First St., Milwaukee, Wis.

Solenoid-Operated Valves

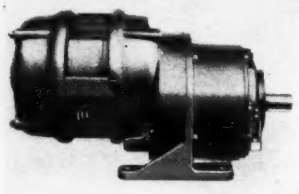
Two-, three- and four-way types of this Nicholson solenoid-operated valve are available. Unit is recommended where it is desired to operate single- or double-acting cylinders by remote control through a pushbutton station or automatic time cycle device. Embodied in unit is the flat disk, regrinding type of valve made by this company for some years. It is not a "packless" valve, but has a large stuffing box in addition to beveled shoulder on stem seating against body, giving two seals. Model S-O shown. Model S-R has ratchet and rotary disk and solenoid is energized only momentarily to move disk from one position to another. This type is preferable where operation requires valve to remain in a certain position for a considerable length of time. Both models for operation on 110 220, 440 or 550 volts, a.c. or d.c. Also special valves.



W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa.

Geared Motors

Ideal geared motors have gear reduction unit mounted directly on motor shaft. Available in all gear ratios from 2.09 to 1 up to 376 to 1, giving output speeds of from 861 to 4.7 r.p.m. using standard 1,800-r.p.m. motor supplied. Ratios up to 6 to 1 use reducers with single-stage helical gears. Those up to 24.5 to



1 use two-stage helical-gear reducer, and above 30 to 1 use one stage helical and one stage heliocentric. All gears run in an oil bath, and anti-friction ball or roller bearings are used. Units using heliocentric gears (illustrated) have motor hung on reducer. Others have reducer hung on motor. Supplied in all horsepowers from $\frac{3}{4}$ to 20. Either open or inclosed-type motors are furnished for 2- or 3-phase a.c., or for d.c. Two-, three- or four-speed types.

Ideal Electric & Mfg. Co., Mansfield, Ohio.

Condenser Tube Corrosion

(Cut at right)

This method of decreasing corrosion of condenser tubes is based on the theory that condenser tube corrosion is caused by oxygen contained in the circulating water, and is designed to remove as much of this as possible.

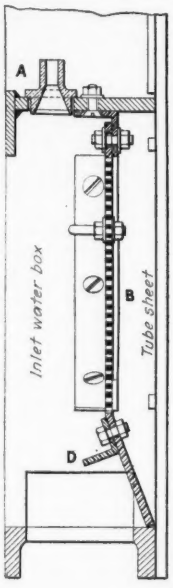
Offtake funnels *A*, which are connected to discharge piping of condenser circulating water system, are located in inlet water box, so that air collecting at top of chamber will be carried to condenser discharge before it has an opportunity to act upon condenser tubes. Screen, *B*, of mild steel, is placed in front of inlet condenser tube sheet to provide cheap and easily replaced material for oxygen to act upon before coming in contact with condenser tubes. Thus, part of air is removed mechanically through funnel offtake and part is used up in oxidizing mild-steel screen, leaving very little air entering condenser tubes to cause corrosion. Angle *D* is placed to cause increased turbulence and a greater separation of air from water.

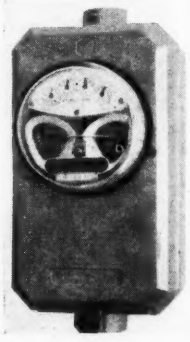
Condenser Service & Engineering Co., 310 12th St., Hoboken, N. J.

Proportioning Motor Valve

Type V 92-1 Minneapolis-Honeywell proportioning motor valve constitutes part of a new electric control system for temperature, humidity, liquid level, stoker or pulverized feed, etc. Unit is operated from a thermostat, expansion thermometer, humidistat, pyrometer or pressure switch, arranged with a slide-wire mechanism. In accordance with demands of control unit, this motor proportions the movement of valves, louvers, rheostats, induction voltage regulators, etc.

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.

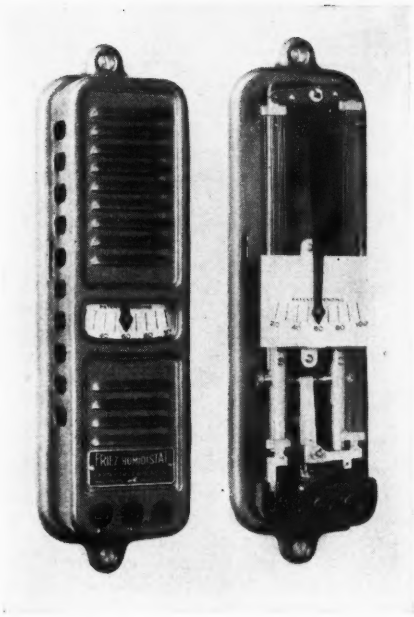




Protective Cases for Watthour Meters

Aluminum-alloy die-cast case for protection of single-phase watthour meters is strong, durable and corrosion-proof. In addition, access to meter is impossible without leaving positive evidence, either by breaking seal or by damaging case itself. Modernistic shape. Water cannot enter case through space between meter cover and box cover, thick rubber gasket under compression being employed there. Should water seep in around joints between cover and box, it is prevented by a dam from running down into conduit.

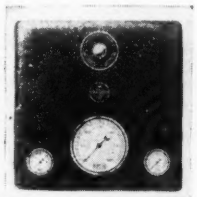
General Electric Co., Schenectady, N. Y.



Automatic Humidity Control

The Friez humidistat has hygroscopic elements of human hair similar to those used in the company's hygro-thermographs. Index hand provides means of setting controller along visible scale to maintain any point of humidity from 20 per cent to saturation. Instrument can be used with either 3- or 2-wire contacts. Contacts designed for either close range or wide range adjustment in terminals with open or closed wiring. Small dimensions, heavy construction and proper ventilation. Illustrated are outside of case and interior view showing hair elements, three-wire contacts and setting lever action.

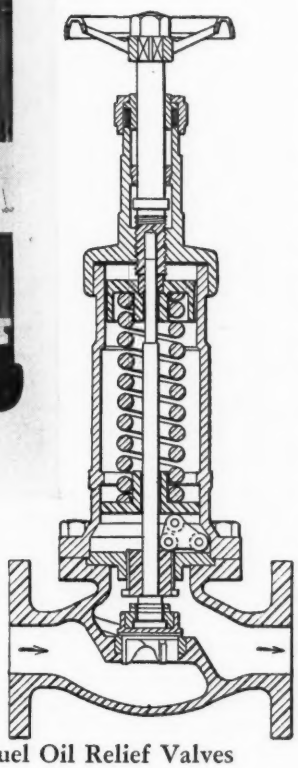
Julien P. Friez & Sons, Inc., division of Bendix Aviation Corp., 4 N. Central Ave., Baltimore, Md.



Differential Draft Control System

This new controller is of the instrument type, and regulates the amount of air passing through furnace in accordance with natural draft of stack, and also the quantity of fuel consumed. In order to accomplish this the Mason instrument controls the feed of forced or induced draft blowers, inlet, or up-take or stack dampers, or any other suitable means for controlling air flow to the furnaces. Air-operated.

Mason Regulator Co., 1190 Adams St., Boston, Mass.



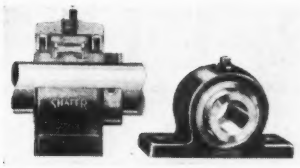
Fuel Oil Relief Valves

Special relief valves with spring compensator have compensating mechanism interposed between sliding plug and spring plate consisting of three links substantially made mounted on a link bracket 120 deg. apart around the vertical spindle. Ends of links bearing on plug and spring plate are fitted with hardened rollers, centers of which are so located that during vertical movement as valve opens or closes horizontal distance between fixed center and center of lower roller remains practically constant while corresponding distance between fixed center and center of upper roller changes. This leverage variation compensates for increased tension of spring as valve lifts. Screw spindle permits pressure adjustment from 15—600 lb. Built-in globe and angle-type bodies; operating mechanism totally inclosed; no moving part passes through stuffing box.

Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.

Light-Duty Roller Bearing

This line of single-row self-aligning radial roller bearings uses a single-row Shafer concave bearing of full roller type with rollers operating between a straight outer race and a convex inner race. This assures liberal radial load capacity, with ample provision for limited

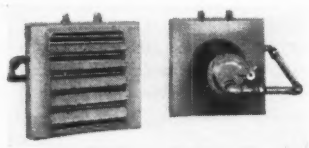


thrust capacity needed in applications having moderate loads. Full self-alignment is a feature. Retainer is omitted, and 50 per cent more rollers added. Thrust is taken by means of hardened and ground thrust plates. Bearing used in these units also obtainable separately. In addition to pillow blocks illustrated, light-duty bearings are available in flange units, hanger boxes and take-up units for shafts from $\frac{9}{16}$ in. to $2\frac{3}{16}$ in. inclusive.

Shafer Bearing Corp., 621 S. Kolmar Ave., Chicago, Ill.

Turbine-Driven Unit Heater

Murray turbine unit heater drive claimed to save electric power cost, since steam drives turbine and exhausts from turbine into heater, where it is con-

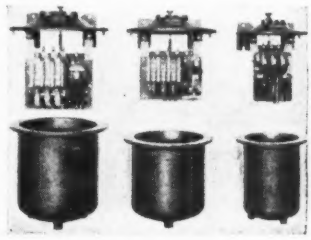


densed at atmospheric pressure. Eliminates wiring, starters, fuses, fire hazards and failure of heat due to failure of electric current. Steam admitted to heater through cast-iron header, into which are expanded several banks of heavy copper tubes with brass radiating fins. Air blown over coils by means of turbine-driven fans. Assembly inclosed in substantial sheet metal box. Also available as electrically-driven heaters.

Murray Iron Works Co., Burlington, Iowa.

Full-Voltage Magnetic Switch

Full-voltage magnetic switches built to standards of Underwriters' Laboratories for industrial control equipment Class I, Group D hazardous locations, are weatherproof as well as being suitable for use in corrosive atmospheres. Consist of standard G.E. magnetic switches with special operating coils and special contact tips for opera-

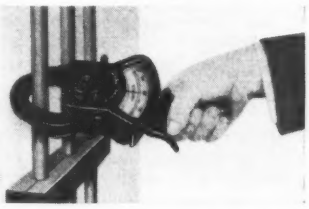


tion under oil, and an oil-immersed temperature overload relay. Cylindrical cast-iron oil tank and top cover have wide metal-to-metal flanges machined to close limits to insure tight fit. Inclosure is, in itself, explosion-proof. Switch and relay are fastened to top cover and extend down into oil. Relay can be reset by means of button extending through top cover.

General Electric Co., Schenectady, N. Y.

Tong-Type Testing Ammeter

Where it is not convenient or permissible to interrupt a d.c. or a.c. circuit long enough to connect a current-measuring instrument in the line, this "Tong-



Test" ammeter permits these measurements to be made easily and quickly. Instrument of split electromagnet type, with no electrical windings, and operable with one hand. Accommodates cables up to $1\frac{5}{8}$ in. in diameter. Total weight of instrument $2\frac{1}{4}$ lb. Interchangeable elements may be had, which permit full range of scale to be 50, 100, 150, 200 or 400 amp. Instrument requires no shunts or ratio transformers.

Columbia Electric Mfg. Co., 1293 East 53rd St., Cleveland.

Oil Circuit Breaker

This 5-kv., 3,000-amp., 50,000-kva., 3-pole, non-oil throwing type indoor form oil circuit breaker has welded square tank. Straight-line motion mechanism composed of non-magnetic steel parts operates under heavy Everdur domed tank head, eliminating magnetic heating. Terminals and bushings are copper bars with wrapped impregnated bakelized paper. Terminals are held to the domed head by means of non-ferrous clamps.

Delta-Star Electric Co., 2400 Block, Fulton St., Chicago, Ill.

POWER LINES

Lubricating Oil Fire Damages Burlington Station

Fire which followed breaking of a lubricating system oil pipe damaged the recently installed 18,000-kw., 3,600-r.p.m. turbo-generator at the modernized 53,000-kw. Burlington (N. J.) station of Public Service Electric & Gas Company on Jan. 23. The turbine was partially enveloped by flames, which persisted for some time despite the efforts of company employees and city fire-fighting forces. The casing is thought to have been warped by the heat and possible internal damage may have occurred, but this can only be determined by full examination later. Station structural elements were also damaged.

According to officials, the turbine, which had been removed from service Dec. 15, 1932, for examination and adjustment, was re-started Jan. 21 and subsequently developed a vibration, which presumably led to the rupture of a line carrying lubricating oil to the unit. Upon breakage of the pipe the escaping oil ignited, possibly induced by the surfaces with which it came in contact. None of the other generating units at the station appear to have been badly damaged, combative efforts confining the flames to the general area of origin.

The turbo-generator is an 18,000-kw. unit operating under a steam pressure of 650 lb. per sq.in. and at a temperature of 850 deg. It was the first high-pressure unit to be installed by Public Service and is one of the few 3,600-r.p.m. units thus far built.

Two Turbines Carry 1.8 Per Cent of U. S. Central Station Load

During the last half of 1932, two turbines delivered 1.8 per cent of the total energy output of central-stations in the United States. These units, producing 691,754,000 kw.-hr. (U. S. total for last half, 1932, was 38,581,974,000 kw.-hr.) are the two 160,000-kw. turbine-generators constituting the final addition to the Hudson Avenue Station of the Brooklyn Edison Co. This plant, described in *Power*, May 31, 1932, is the world's largest steam-electric station with a present capacity of 770,000 kw. under one roof.

Edison Electric Institute Replaces National Electric Light Association

After much discussion, the National Electric Light Association has been dissolved and a new organization called the Edison Electric Institute has been formed with George E. Cortelyou as president and leading holding and operating property executives as trustees. Only utilities will be represented in the new organization with company, individual and honorary memberships. The institute is expected to absorb both the N.E.L.A. and the Edison Association to form a single utility association.

The feature of the institute is its constitution: Members must make definite commitment to follow the business principles laid down; the power of discipline is given the officers; definite requirements are made as to the filing of audited financial statements; individual membership must be approved by the companies with which the members are connected, and power is given the officers to investigate the business practices of member companies. Objects of the institute are to advance the art of business, collect and disseminate data and statistics and aid member companies in all ways that are in the interests of consumers, investors and employees.

Boiler Manufacturers Aid Industrial Rehabilitation

George W. Bach, vice-president and general manager of the Union Iron Works, Erie, Pa., been appointed division chairman of the Robertson Industrial Rehabilitation Committee for that district. W. C. Connelly, manager of the Cleveland District of the Foster Wheeler Corporation and formerly president of the Connelly Boiler Co., has been appointed division chairman in Cleveland, Ohio.

COMING MEETINGS

National Marine Engineers' Beneficial Assn.—58th annual convention, Lee House Hotel, Washington, D. C., Feb. 13-17. A. L. Jones, secretary-treasurer, 313 Machinists' Bldg., 9th St. & Mt. Vernon Pl. N.W., Washington, D. C.

Technical Ass'n. of the Pulp & Paper Industry—Annual Meeting, Pennsylvania Hotel, New York City, Feb. 13-16. R. G. MacDonald, Sec.-Treas., 370 Lexington Ave., New York City.

Sixth Midwest Engineering & Power Exposition — Coliseum, Chicago, Ill., during "Engineering Week," June 25-30, of the Century of Progress Exposition. Headquarters, 308 W. Washington St., Chicago, Ill.

American Society for Testing Materials—Annual Meeting, The Stevens, Chicago, Ill., June 26-30. C. L. Warwick, Sec.-Treas., 1315 Spruce St., Philadelphia, Pa.

Leipzig Trade Fair—March 5-12, Leipzig, Germany. Information from Leipzig Trade Fair, Inc., 10 East 40th St., New York, N. Y.

Diesel Engine Users' Ass'n.—Annual Dinner, Feb. 7, Coventry Restaurant, Wardour St., London W.I., 7:30 p.m. Hdqtrs: 307, Abbey House, Westminster, London, S.W.I.

American Ceramic Society—35th Annual Meeting and second meeting of Nat'l Brick Mfr's. Research Fndtn., Hotel William Penn, Pittsburgh, Pa., Feb. 12-17. Also exhibit of ceramic materials and equipment. Hdqtrs: 2525 N. High St., Columbus, Ohio.

American Institute of Mining and Metallurgical Engineers—142nd Meeting, Engineering Societies Building, 29 West 39th St., New York City, Feb. 20-23. Headquarters there.

Middle West Division, N.E.L.A.—Engineering conference, Kansas City, Mo., Feb. 10-11. Thorne Brown, 1527 Sharp Bldg., Lincoln, Neb.

New England Division, N.E.L.A.—Engineering Section, Boston, Mass., March 2-3. O. A. Bursiel, 20 Providence St., Boston.

National Engineering Section, N.E.L.A.—Committee meeting, Detroit, Mich., April 10-14. A. J. Marshall, 420 Lexington Ave., New York

E. C. Hutchinson Resigns

Power announces the resignation of Ely C. Hutchinson as its editor and his election to the presidency of the Edge Moor Iron Co., of Edge Moor, Del., on Feb. 1.

Mr. Hutchinson brought to *Power* the vision and contacts of one who for years served as an executive in the field of power machinery manufacturing. In returning again to this field he leaves a heritage, the effect of which will long be an inspiration to his associates.

Philip W. Swain continues as managing editor, with a staff splendidly trained and attuned to the best interests of the field.

Mr. Hutchinson goes to the Edge Moor Iron Co. with the good wishes of his associates on *Power* and throughout the McGraw-Hill Publishing Co.

Diesels Prominent at Boat Show

At the Annual Boat Show in Grand Central Palace, New York, during the week of Jan. 21-28, internal combustion engines, and diesels in particular, were more prominent than ever before. Outstanding was the new steel-type Winton-Diesel available in sizes from 300 to 1,000 hp. with crankcase and cylinder block of welded steel plate in one piece. Eight chrome-nickel-iron cylinder liners are inserted in this block, and 18 through tiebolts absorb combustion forces. Diesels as small as 18 hp. were included in some displays. Atlas-Imperial converted a gasoline engine to oil by adding a new "common-rail" type fuel injection system with electrically operated spray valves and spark-plug ignition. Only cylinder heads were changed.

A.I.M.E. Coal Division Meets This Month

Included in the technical program of the 142nd meeting of the American Institute of Mining & Metallurgical Engineers at the Engineering Societies Bldg., New York, Feb. 20-23, are two meetings of the Coal Division on Feb. 20. Some papers are:

"Use Classification of Coal for Stationary Steam Generation," by T. W. Harris, Jr.; "Relationship Between Round and Square-hole Screens for Coal," by H. F. Yancey and R. E. Zane; "Application of Micropyrometer for Determining Fusibility of Coal Ash," by Roy P. Hudson; "Plant Capacity and Carrying Charges, and Effect Thereof on Value of Coal Properties," by W. H. Craigue; "Competitive Relation of Coal and Petroleum in the United States," by W. Spencer Hutchinson and A. J. Breitenstein; "Some Physical Properties of Pennsylvania Anthracite and Related Materials," by J. Leland Myer.

International Exchange for Hydraulic Laboratory Research

As a step in a wider scheme now before the World Power Conference, the American Committee, through its chairman O. C. Merrill, has recently issued a letter to approximately 100 hydraulic laboratories in the United States proposing to create an agency for exchanging information in this country on the subject. Mr. Merrill has stated that any one interested in cooperating in the proposal may communicate either with the office of the American Committee at 1419-21 Chrysler Bldg., 405 Lexington Ave., New York, N. Y., or with the U. S. Bureau of Standards.

World's Fair Pumping Stations Near Completion

The pumping station that will provide the water supply for Chicago's 1933 World's Fair, "A Century of Progress Exposition," is rapidly approaching completion north of the Park Row station of the Illinois Central System. It connects with the Park Row shaft of the 14th St. water tunnel of the City of Chicago. Water will be pumped from that shaft through the piping system on the Fair grounds.

Three Worthington centrifugal pumps are being installed. While capacity is 28,000,000 gal. daily, except in emergencies only two pumps will be used, with the third kept in reserve. Pressures will vary from 75 lb. at the station to 25 lb. at 39th St., the southernmost limits of the grounds. A total of 13 mi. of water pipe will be required, all Armco spiral-welded, asphalt-coated steel. Buildings and grounds on Northerly Island, which adjoins the mainland, will be served by this system also.

In addition to the water pumping system, a sewage pumping system to meet the requirements of 1,000,000 persons a day is being installed. There are four pumping stations—at 20th St., 25th St., 35th St. and one on Northerly Island opposite 19th St. There will be three Yeoman centrifugal open-impeller type pumps in each station, two operated constantly, with the third in reserve. The sewage pumping system of the Fair grounds will be connected by force mains to the sewage mains of the city. Total capacity of the World's Fair system will be 22,500 g.p.m.

Steam-Ejector Refrigeration

Westinghouse Electric & Mfg. Co. has recently tested at its South Philadelphia Works a piece of refrigerating equipment of large capacity using steam ejectors to produce the cooling effect. Except for some small pumps, there is no rotating apparatus in this equipment, and the complete unit is simple and fairly small in size. This ejector equipment is particularly adaptable for types of refrigeration applications where process steam is available, such as in air-conditioning, for example.

Cooper-Bessemer Celebrates Centenary

The Cooper-Bessemer Corp., Mt. Vernon, Ohio, one of the oldest builders in the United States of oil and gas engines, celebrated its centenary with the beginning of 1933. Two brothers, Charles and Elias Cooper, built a small iron foundry at Mt. Vernon in 1833 and thereby laid the foundation for a business now valued at $8,000,000. The company first made plow castings and saw mill machinery, then the first steam locomotive built west of the Alleghenies, and in the late 50's designed and built the Corliss engine for distribution in the west. The gas-engine division of the company built in 1908 a single gas engine of 1,000 hp., then began building the great compressors now used on natural gas pipe lines.

Frank Bonner Wins Case

The trial of Frank Bonner versus the New England Publishing Co. for libel growing out of material published by the "Boston American" during Mr. Bonner's term as secretary of the Federal Power Commission during 1929 and 1930 was held Jan. 3-19. The jury awarded verdict for the plaintiff and assessed $50,000 damages. Similar suits are pending in a number of other cities, the Boston case being the first to come to trial.

1932 Fuel Consumption Shows 31 Per Cent Decline

Total consumption of the principal forms of fuel and power in the United States will probably show a 31 per cent decline for 1932 as compared with 1929, according to an announcement by the National Industrial Conference Board. Of the five principal sources of fuel and power, coal has suffered the greatest decline since 1929. In 1929, coal furnished 64 per cent of the energy supply, while in 1932 it represented only 56 per cent of the total. Consumption of all kinds of coal has fallen off 40 per cent, while that of other sources of energy has declined only 15 per cent. Bituminous coal shows a decline of 41 per cent, anthracite of 30 per cent. The coal equivalent of hydro-electric power declined 15 per cent, and that of natural gas, after deduction of the amount used for carbon black, probably from 20 to 25 per cent. The group of oil products used for energy showed an average decline of 12 per cent, the material decline in fuel oil consumption of 22 per cent being offset by a decrease of only 1 per cent in motor fuel demand.

While the demand for total public-utility electric power has fallen off about 15 per cent, the output from water power has declined only 3 per cent. Hydro-electric power, in the main, fills the steady or base-load demand and is affected principally by conditions of water supply, while fuel-electric power responds to a greater extent to variations in total demand for electrical power.

Advance Studies for Disengaged Engineers

Advanced studies for disengaged engineers, sponsored by Engineering Societies and Engineering Colleges of the New York-New Jersey Metropolitan District, made possible by individuals and by cooperation of others who offered their services, began Jan. 9, under auspices of The Engineering Foundation. Three hundred seventy-two disengaged engineers registered, 104 registrants indicating Power-Plant Engineering.

PERSONALS

HOWARD COONLEY, president of the Walworth Co., New York, has been elected president of the American Standards Association for the year 1933.

J. H. CONNORS, vice-president and general manager of B. F. Goodrich Co. mechanical goods division has been re-elected by acclamation chairman of the Mechanical Goods division of the Rubber Manufacturers Association. He has been connected with Goodrich mechanical goods activities for more than 20 years.

W. J. DANA, formerly with North Carolina State College, has become professor of Mechanical Engineering at Duke University, Durham, N. C. At the 16th annual meeting of the North Carolina Society of Engineers in Raleigh, Jan. 14, he was elected president. He was vice-president last year.

JAMES F. FOGARTY, New York vice-president of The North American Co., has been elected president of North American Light & Power Co. to fill the vacancy caused by the death on Jan. 22 of Edwin Gruhl. Mr. Fogarty has been a director since July, 1932.

JAMES C. KENNEDY, formerly president of the Central & South West Utilities Co., Dallas, Tex., and chairman of the Central Power & Light Co., has been elected president of the latter.

F. J. KING, chief engineer of Linde Air Products Co., has been elected president of Compressed Gas Manufacturers' Association.

WILLIAM G. KREITNER has been appointed vice-president in charge of heating and ventilating of the Building Expense Control Co., Inc., building manager of numerous office and apartment buildings in New York. He was formerly heating engineer with Modine Mfg. Co. and was for five years engineer in charge of construction and service for Milwaukee Valve Co.

DR. J. MITCHELL FAIN, consulting chemist, is now associated with Foster D. Snell, Inc., 130 Clinton St., Brooklyn, N. Y.

J. W. ORCUTT has been elected president of the Engineers Club of Birmingham.

R. B. BEALE, formerly asistant manager of the Turbine Sales Dept., General Electric Co., has succeeded Elmer E. Gilbert who recently retired as manager of the department. Mr. Beale becomes manager of the turbine division, the Turbine Sales Department having been consolidated with the Central Station Department.

R. B. Beale

WILLARD R. PLATT has resigned as president and secretary of Greene, Tweed & Co., 109 Duane St., New York, N. Y., and Harold B. Platt has resigned as vice-president and treasurer. Henry S. Demarest, having acquired a controlling stock interest, has been elected president and treasurer, James A. McKeon, vice-president and Herbert A. Erwood, secretary.

J. A. MORGAN, formerly engineer at the New York office of Davis Coal & Coke Co., Baltimore, Md., has been made district engineer of the Philadelphia territory with offices in the Land Title Bldg.

HERBERT V. COHO has been appointed business manager of the Cork Insulation Mfrs. Association, Grand Central Terminal, New York City.

E. A. LIVINGSTONE has been appointed a sales representative of Babcock & Wilcox Co. and Babcock & Wilcox Tube Co., with headquarters at 85 Liberty St., New York City. For six years prior to his joining B&W he was connected with A. O. Smith Corp.

FRED NORCROSS, manager of the Home Gas & Electric Co., Greeley, Colo., who was elected president of the Rocky Mountain division, National Electric Light Association, will assume his duties immediately because of the resignation of W. W. Nielsen early in December.

BUSINESS NOTES

GURNEY ELEVATOR CO., 109 W. 64th St., New York, N. Y., has been incorporated and has taken over the business and assets of Gurney Elevator Co., Inc., which has been operating under an equity receivership since April 1 of last year. Officers will be C. R. Callaway, president, who was vice-president of Gurney Elevator Co.; L. A. Howell and F. H. Dunning, vice-presidents; and L. H. Ross, secretary and treasurer.

HERPEN & VORKAUF, Berlin, N.W. 7, Schadowstrasse 1b, Germany, has been formed to handle the foreign and domestic patent rights of the "whirling boiler" invented by Dr. Ing. H. Vorkauf and described in *Power* in November, 1932. Pending further practical tests in Germany, it is understood that nothing is being done to push the licensing for manufacture of this equipment in the United States.

NIAGARA COMBUSTION CORP., 150 Portage Road, Niagara Falls, N. Y., has appointed the following district sales managers: W. H. Bottger, 829 71st St., Brooklyn, for the metropolitan area, New York; William C. Stamm, 218 Idell St., Mount Airy, Philadelphia, for Philadelphia district, and G. F. Weizel, 3810 Shaw Blvd., St. Louis, for the St. Louis district.

MOORE-HANDLEY HARDWARE CO., 25 S. 20th St., Birmingham, Ala., has been appointed distributor and direct representative for the Link-Belt Co. in the Birmingham territory.

CENTRIFIX CORP., 3029 Prospect Ave., Cleveland, Ohio, has appointed Louis G. Schertl, 1134 N. 4th St., Milwaukee, to handle the company's line of purifiers in the Wisconsin territory.

WM. B. SCAIFE & SONS CO., Oakmont, Pa., has opened a sales and engineering office at 42 East Ave., Rochester, N. Y., under management of F. H. Wisewell.

CONSOLIDATED GAS, ELECTRIC LIGHT & POWER CO., Baltimore, Md., has purchased control of the Consolidated Public Utilities Co., which supplies electricity, gas and water in and around Westminster, Md., subject to approval of the Public Service Commission.

GALIGHER CO., 228 South West Temple St., Salt Lake City, Utah, has taken over the Salt Lake City agency for Roller Smith Co., 233 Broadway, New York, N. Y., to supersede H. J. Hersey & Co., who have been Roller-Smith agents in Salt Lake City for some time.

NORMAN J. GOULD, president of Gould's Pumps Inc., has announced acquisition of the Hydroil Corp., Lebanon, Ind., manufacturer of oil purifying apparatus. The Lebanon plant is being discontinued and the business and equipment will be transferred to the Seneca Falls plant of the Gould company. D. B. Clark, vice-president of Hydroil and W. P. Alexander, factory and field representative, will join the Gould organization.

BERNITZ FURNACE APPLIANCE CO., 89 Broad St., Boston, Mass., has appointed McLean Peterson Co. as agent in southwestern Ohio, including Dayton, Springfield and Columbus, and Reese-Wilson Engineering Sales Co. as agent in Cleveland and northeastern Ohio.

MERCON REGULATOR CO., 1 La Salle St., Chicago, Ill., has appointed the following district representatives: Laney Co., Kennedy Bldg., Tulsa, Okla.; Ambler & Riter, Inc., 810 Fourteenth St., Denver, Colo.; L. J. Riter, Kearns Bldg., Salt Lake City, Utah; Hughes Machinery Co., Mfrs. Exchange Bldg., Kansas City, Mo.

GEORGE M. SHARER has been appointed sales manager of the eastern division, with headquarters in Philadelphia, of the Link-Belt Co., 910 S. Michigan Ave., Chicago. Mr. Sharer will have direct supervision of sales of all of the company's offices in the Atlantic Coast States.

ROCKBESTOS PRODUCTS CORP., New Haven, Conn., has changed its Chicago sales office and warehouse from 718 Madison Terminal Bldg., to 847 Marquette Bldg., 140 S. Dearborn St., Chicago, Ill. H. S. Sines remains manager.

FRED S. RENAULD has been appointed Southern California district sales agent for Erie City Iron Works. His office will be at 1816 W. 75th St., Los Angeles.

OBITUARIES

KARL F. SNOW, 70, cofounder of the C. O. Bartlett & Snow Co., Cleveland, 46 years ago, died there Jan. 30 after a brief illness.

DR. ERNST VON BORSIG, 63, head of the famous locomotive works that bears his family name, died of a heart attack Jan. 5 at his country estate in the Province of Brandenburg, Germany.

JAMES A. COE, 85, president of James A. Coe & Co., 395 Washington St., Newark, N. J., died Jan. 5. He established the firm of Crowell & Coe with his brother-in-law about 60 years ago.

KATE GLEASON, 67, industrialist, noted engineer and philanthropist, died of pneumonia at her home in Rochester, N. Y., Jan. 9. She was the first woman member of the A.S.M.E., first woman president of a national bank in the United States, and exceedingly successful manager of Gleason Works, Inc., from which she retired in August, 1918.

EDWIN F. GRUHL, 46, president of the North American Co., one of the largest public utility corporations in the world, died unexpectedly Jan. 22 at his home in New York. He had been a leader in dissolving the N.E.L.A. and in creating the Edison Electric Institute. Besides his connections with utilities and corporations handling public utility investments, Mr. Gruhl was president of the Association of Edison Illuminating Companies.

JOHN J. HARTLEY, 39, Western Division chief engineer, Link-Belt Co., Chicago, died Dec. 31, 1932.

CHARLES F. MEDBURY, 66, for the past 23 years manager of the Montreal office of the Canadian Westinghouse Co., died Nov. 2. He went to Thomas-Houston Electric Co. first as draftsman and later as engineer. After several other positions, he went to Chicago as a salesman for Westinghouse Electric & Mfg. Co., subsequently becoming manager of the Detroit office, where he remained until 1909.

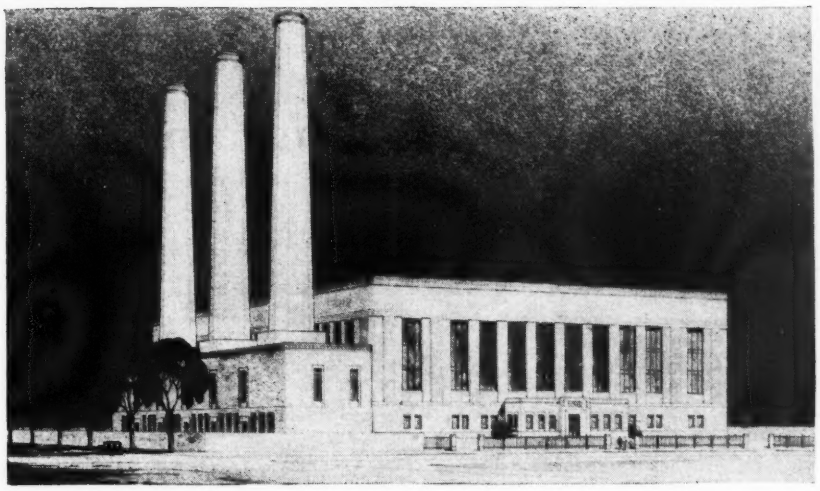
HOLBROOK FITZ JOHN PORTER, 74, internationally known engineer and secretary of the National Museum of Engineering & Industry, died recently of pneumonia.

JOHN D. ROBB, sales manager of the Dominion Engineering Works, Ltd., died recently at Lachine, Que., after a short illness.

PAUL A. TILLERY, 63, president of the Carolina Light & Power Co., Raleigh, N. C., died there recently. He had been connected with the company for 23 years.

CHARLES HEAD SMOOT, 55, president of the Smoot Engineering Corp., 136 Liberty St., New York, N. Y., died Jan. 6 at Maplewood, N. J. He had been associated with many engineering projections and was the inventor of Smoot control, also of many improvements in the design of high-speed turbines and turbo-blowers. He was associated with the Western Electric Co., was engineer and director of Rateau Steam Regenerator Co., chief engineer of Rateau Battu Smoot Co., and president of the Smoot Engineering Corp. He was also a member of the Inventors' Guild, A.S.M.E., Engineers Club and Engineers Society of Western Pennsylvania.

Charles Head Smoot



The new Buzzard's Point Station of Potomac Electric Power Co.

STRAWS

Pointing the way the business wind blows

In anticipation of the return of beer, many brewers are planning improvements, plant additions and the purchase of new equipment. Several expenditures noted are:

Cleveland Home Brewing Co., $125,000; Kings Brewery, Inc., $1,500,000; Rosebud Ice Co., Fremont, Ohio, $75,000; Fidelio Brewery, Brooklyn, N. Y., a new brewery; Theodore Hamm Brewing Co., etc., St. Paul, alterations and new equipment; Bartels Brewing Co., Syracuse; Jacob Ruppert Brewing Company, New York City, $5,000,000; Blatz Val Brewing Co., more than $1,500,000; Miller Brewing Co., Milwaukee, $1,000,000; Pabst Corp., $2,000,000; Cream City Brewing Co., between $100,000 and $150,000; New Amsterdam Brewing Co., New York City, $2,500,000; Aztec Brewing Co., San Diego, Calif., has purchased a building at $500,000; Vernon (Calif.) Brewing Co., bottling and refrigeration plant, $150,000; Wehle Brewing Co., West Haven, Conn., brewery, $40,000; Premier Products Co., Milwaukee, brewery alteration, $4,000,000; Columbia Breweries, Inc., Tacoma, Wash., enlargement; Hemrick, Inc., Seattle, Wash., improvements, $10,000; Chautauqua Brewing Co., Jamestown, N. Y., 40,000-share stock issue for working capital; City Ice Co., Atlantic City, N. J., having modernization survey made; Falstaff Corp., St. Louis, Mo., has expanded capital from $750,000 to $2,500,000; Billings (Mont.) Brewing Co., alterations including refrigerating plant; Niles (Mich.) Malt Co., transformation plans; Peoples Brewery, New Orleans, La., brewery to cost $300,000; Cremo Brewery, New Britain, Conn., plant rehabilitation; G. Muller, brewery at Miami, Fla., to cost $500,000; Northwest Brewing Co., Tacoma, Wash., plans remodeling brewery at Walla Walla to cost $50,000; Liberty Brewing Co., Pittston, Pa., plans installation of new equipment in the Glennon Brewery; Knight Brewery, Glens Falls, N. Y., reconditioning; G. Zett Brewing Co., Syracuse, N. Y., planning improvements; Pilsner Ice, Fuel & Beverage Co., Cleveland, Ohio, planning improvements and additions; Ohio State Brewing Co., Columbus, Ohio, organizing a $400,000 brewery; J. D'Agostino, care L. N. Renault & Son, Egg Harbor City, N. J., plans altering brewery at Philadelphia, Pa., to cost $500,000; Sayre Brewing Co., Sayre, Pa., will contract for new equipment; Victor Brewing Co., Pittsburgh, Pa., $200,000 stock offering for reconditioning; Stark Tuscarawas Brewery Co., Canton, Ohio, new refrigerating equipment; Chicago Brewing Co., 64 W. Randolph St., has let the contract for a $1,000,000 brewery; F. W. Cook Brewery, Evansville, Ind., reconditioning; Dubuque Star Brewing Co., Dubuque, Ia., complete rehabilitation; Falls City Ice & Beverage Co. plant, Louisville, Ky., in process of increasing ice plant and overhauling; Murry Vorhees, Lakeside Park, Covington, Ky., planning alterations and equipment, $500,000.

Electric Machinery Mfg. Co. has been awarded a contract by the United Engineers & Constructors, Philadelphia, consulting engineers for the Bogalusa Paper Co., involving seven 250-hp., 450-r.p.m. synchronous motors to drive jordans. This contract is part of the major improvement program at Bogalusa.

Gatineau Power Co., Ottawa, Ont., reports that its November, 1932, production of electric energy was the highest for that month in the history of the company. It reached 245,323,000 kw.-hr., or 15 per cent over November, 1931. A new, high single-day output record of 9,864,428 kw.-hr. was reached Dec. 31.

Yuill & Knight, electrical engineers, West Pender St., Vancouver, B. C., have commenced repairs at the Cranby dam for the City of Grand Forks, B. C. The company recently completed erection of a new power plant for the city.

Electrical metering and switching equipment for Cincinnati's new $41,000,000 railroad terminal has been ordered from Westinghouse Electric & Mfg. Co., the order approximating $150,000. The terminal will include a power house.

Construction contracts totaling $255,000 have been announced by the Navy Department. They include an electrical distribution system at St. Juliens Creek (Va.) naval ammunition depot, awarded to Montgomery (Ala.) Electric Co., for $57,000.

New water power brought under development in Canada during 1932 amounted to 378,923 hp., according to the natural resources department, Canadian National Railways. This brings the water power installation of the Dominion up to 7,045,260 hp.

Moore-Handley Hardware Co., Birmingham, Ala., has just placed a contract with Link-Belt Co., for two solid carloads of Link-Belt chains, conveying and power transmission machinery.

The Navy Department will open bids on Feb. 14 for steel boiler tubes and electric refrigerating units and on Feb. 7 for lubricating oil coolers.

Seven complete air conditioning systems, all automatically controlled, will supply 315,000 cu.ft. of air per min. in the new National Archives Bldg., now under construction in Washington. The system, sold by York, will include sulphur dioxide removing units and ionizers to remove odors. Four York freon compressors will provide refrigeration equivalent to 1,000 tons of ice melted per 24 hr.

The transit department of the City of Boston, Mass., E. F. Condon, sec., 1 Beacon St., is asking for bids until Feb. 13 on the electrical supply for light and power for the new East Boston traffic tunnel.

J. O. Ross Engineering Corp. has recently completed refueling of the Stratton furnace settings installed several years ago at the Bridgeport (Pa.) plant of Continental-Diamond Fibre Co. Originally two Stratton furnaces were installed under two Heine 435-hp. boilers in battery setting and designed to operate at 200 per cent rating. Recently, however, it was decided to remove the center wall to a point just above the first tube row and convert the two units into one with an output of 45,000 to 50,000 lb. of steam per hour. This has been done and the unit is now running

Westinghouse Electric & Mfg. Co. has received a $110,000 order for steel mill electric motors and control apparatus ranging from 250 to 1,200 hp.

New construction projects of Virginia Electric & Power Co. during 1933 will involve expenditures of close to $1,000,000.

A petition asking for amendment to the Spokane, Wash., city charter to provide for municipal operation of an electric light and power plant has been filed with the city clerk.

The Book Cadillac Hotel, Detroit, Mich., is remodeling its power plant and will add three Skinner engine-driven generators, boilers and accessories. Total expenditure $125,000.

West Kootenay Power & Light Co. has purchased land at Adams River, B. C., to be used as a site for its proposed hydro power plant. Power development on the Adams River to serve this section of British Columbia fringing on the Okanagan Valley has been contemplated for some time.

Thirty-seven elevators will provide for the transportation needs of the new United States Supreme Court Building in Washington. The contract for approximately $556,000, let to Otis Elevator Co., includes 31 gearless traction signal control passenger elevators, two gearless traction collective control passenger elevators, and four geared traction, self-leveling, car-switch control freight elevators.

A contract amounting to nearly $110,000 for three 5,000-kva. synchronous condensers and insulators has been awarded Westinghouse by the Metropolitan Water District of Southern California for a temporary power line running from Los Angeles to the Colorado at Parker Dam.

Columbia Valley Power Co., is now carrying on negotiations with the village of Williams Lake, B. C., for a franchise agreement concerning operation of the plant over a number of years.

New Bulletins

STEAM TRAPS — Armstrong Machine Works, Three Rivers, Mich., has issued "The Armstrong Steam Trap Book" or Catalog G, illustrating Armstrong steam traps, their application, and supplying charts and specifications to permit their proper selection and application.

CENTRIFUGAL PUMPS — DeLaval Steam Turbine Co., Trenton, N. J., has issued a leaflet, "Efficient Suction Head for Centrifugal Pump Operation," which is a paper presented by A. Peterson, chief engineer of the pump and compressor department of the company, and printed originally in *Power* in August, 1932.

MOTOR-REDUCERS — Philadelphia Gear Works, Erie Ave. & G St., Philadelphia, Pa., has issued Bulletin No. MR 33 on its horizontal and vertical type "MotoReduceR" units.

TESTING SIEVES—Newark Wire Cloth Co., 351-365 Verona Ave., Newark, N. J., has issued a six-page folder devoted entirely to that company's new End-Shak Testing Sieve Shaker and its U. S. Standard and A.S.T.M. Standard Cornerless Testing Sieves.

STOKERS & SPECIALTIES—Budd Grate Co., 2011-25 E. Hagert St., Philadelphia, Pa., has issued a bulletin, "Reducing Power Plant Upkeep with Budd Versatile Stokers," which lists types and elements of these stokers with their specifications and includes nine pages of engineering data.

PAINTING—The New Jersey Zinc Co., 160 Front St., New York, N. Y., has issued a bulletin, "Using Paint as Light," which is a rewrite of the highly technical paper given by D. L. Gamble of the research division of the company at the annual convention of the Illuminating Engineering Society recently. A series of simple charts illustrate and demonstrate the effects on work of various wall colors in manufacturing plants.

MERCURY ARC RECTIFIERS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued a 16-page publication on its new sectional-type rectifiers. It is known as publication C-1907-B.

CONVEYOR-ELEVATORS—Stephens-Adamson Mfg. Co., Aurora, Ill., has issued a four-page descriptive folder on the "Redler Conveyor," which is claimed to convey horizontally, vertically, up inclines and even around corners.

TEMPERATURE REGULATORS FOR BRINE CONTROL IN REFRIGERATION—Sarco Co., Inc., 183 Madison Ave., New York, N. Y., has issued a bulletin on its temperature regulators for brine control in refrigeration.

CENTRIFUGAL PUMPS—Pennsylvania Pump & Compressor Co., Easton, Pa., has issued Bulletin No. 218 on the company's Class LS and HLS single-stage centrifugal pumping units of both the horizontal and vertical type. These have the motor and pump mounted as a unit.

CHEMICAL EXHIBITION—"Achema VII," or the exhibition of chemical plant and equipment to be held in Cologne, Germany, in 1933, is announced in a bulletin available from the Deutsche Gesellschaft fur chemisches Apparatewesen E. V., Seelze Bei Hannover, Germany.

RUBBER GUIDE BEARINGS—An 18-page booklet, "Cutless Rubber Guide Bearings as Applied to Hydraulic Turbines," has been published by B. F. Goodrich Rubber Co., Akron, Ohio. Written by R. E. B. Sharp, hydraulic engineer, Baldwin - Southwark Corp., I. P. Morris division, Philadelphia, Pa., and profusely illustrated. Various design and operating elements are given. There are now 42 hydraulic turbines with cutless rubber bearings in operation, with an aggregate capacity of 514,000 hp. Shaft diameters vary from 7 to 31½ in.

BELT CONVEYORS—Robins Conveying Belt Co., 15 Park Row, New York, N. Y., has issued Bulletin 82, "Robins Belt Conveyors," containing tables and charts for determining capacity, speed, width, power and belt-ply of any belt conveyor. Numerous photographs of installations in a variety of industries; specifications and similar information. 100 pages, 8½ x 11.

PUMPS—Goulds Pumps Inc., Seneca Falls, N. Y., has announced its 1933 dealer catalog, including showing of 1,000-g.p.h. shallow-well and 9-in. stroke deep well "CIQ" water system units and a horizontal, double-acting piston pump for industrial service. It includes four sections, shallow and Deep-Well Water Systems, Hand Pumps, Accessories, Industrial Pumps. 128 pages, 200 illustrations.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Belmont—Belmont Water Dist. voted $45,000 for 900,000 gal. storage system, central pumping plant, new mains, 35 hydrants.

Calif., Fresno—Budget funds provided for 5,100 lin.ft. c.i. mains in connection with municipal water distribution system, $16,208; pumping plants in connection with same, $3,080, in addition to $1,500 for field equipment. J. L. Vincenz, city comr. P. Wks.

Calif., San Diego—Bids Mar. 8, by Yards & Docks, Navy Dpt., Wash., D. C., 393½ ft. long x 60 ft. beam steel floating dock, having closed bow and hinged gate at stern, incl. oil engine generator, pumps, piping and electric power and light systems, for Naval Operating Base, Spec. 6352.

Del., Wilmington—Delaware Electric Power Co., 834 Market St., and subsidiaries, will expend $636,794 in 1933 for additions and improvements of which $286,108 will be used for improvement of electric service of company and $138,171 to strengthen gas distribution.

Idaho, Afton—C. J. Call, Pocatello, plans hydro-electric plant, on Swift Creek to supply village and vicinity. $40,000.

Idaho, American Falls—Municipality plans waterworks pumping plant. $20,000 or more.

Ill., North Chicago—City Council surveys electric light and power plant. Neiler, Rich & Co., 431 South Dearborn St., Chicago, engrs.

Ill., Rantoul — Con. Q.M., Canute Field, bids about Mar. 1, central heating plant for aid field group of buildings. $180,000.

Indiana—American Utilities Corp., R. E. Stevenson, pres., 824 Continental Bank Bldg., Indianapolis, plans completed hydro-electric power plant, incl. rein.con. dam, equipment, power station, in Eel River, Owen Co. $2,000,000. **Maturity in summer**

Ind., Peru—City, F. L. Kerns, supt., soon takes bids improving municipal light plant, steam valves, fittings. $25,000. F. L. Kerns, supt.

Ind., Rockville—City made plans waterworks and municipal light plant. $32,000.

Ia., Blanchard—City voted to build municipal electric plant. $39,500.

Ia., Hamburg—City, R. Travis, clk., plans election to vote on proposal to build municipal light and power plant. $150,000.

Ia., Logan—Petitions are being circulated for election to vote on $100,000 bond issue for constructing municipal light and power plant, and distribution lines.

Kan., Great Bend—City plans new power plant and gas system. $300,000. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Louisiana and Mississippi—Bids Feb. 21, by State Hy. Comn., Louisiana Natl. Bank Bldg., Baton Rouge, La., superstructure, machinery and power plant of East Pearl River Bridge, St. Tammany Parish, La., and Hancock Co., Miss., Emergency Hy. Constr. Project F.A. Project E-219-Unit 2.

La., Plaquemine—E. V. Joly, Bayou Goula, plans ice and cold storage plant. **Maturity soon.**

La., West Monroe—Gravity Drainage Dist. 1, c/o Commissioners, work supplementary to U. S. War Department construction of flood protection levee to include flood gates $20,000, pumping units, pump house, foundations $40,000, moving sewer and providing adequate drainage $13,000, moving sewer and watermains on South Riverfront and North Riverfront Sts. $12,000. Bond issue approved.

Mich., Albion—City plans municipal electric plant. $40,000. Burns & McDonnell Eng. Co., Interstate Bldg., Kansas City, Mo., engrs.

Mich., Lapeer — Municipality plans power and light plant. $200,000. Engineer and architect not appointed.

Minn., St. Paul—Bids Feb. 16, by U. S. Treas. Dpt. at office Sup. Archt., Wash., D. C., superstructure 7 and 11 story, 145x280 ft. rein.-con., stone, brick, steel post office and federal building, incl. power plant, conveyors, and postal equipment, 3rd and Jackson Sts. $2,100,000. L. Bassindale, 485 Endicott Bldg., archt. Holabird & Root, 104 South Michigan Ave., Chicago, Ill., assoc. archts.

Mo., Eldorado Springs—City, H. Hapstanstall, clk., election Feb. 14, $75,000 bonds, municipal light and power plant and equipment. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, engrs.

Mo., Rolla — Gasconade River Power Co., 605 R. A. Long Bldg., Kansas City, application filed with Federal Power Comn. for 1,800 ft. dam, 130 ft. high, with turbines, generators to develop 60,000 hp. $15,000,000. D. A. Dean, **605 R. A. Long Bldg, Kansas City, engr.**

N. J., Burlington—Public Service Corp. of New Jersey, Burlington, and Terminal Bldg., Newark, subsidiary of U.G.I., 112 North Broad St., Phila., Pa., plans repairing power plant and replacing equipment. To exceed $250,000.

N. Y., Lawrence—Bids Feb. 14, at office Village Clerk, Village Hall, Contr. A, sewage treatment plant, on Doughty Blvd., consisting rein.-con. Imhoff tank, chlorinating station, grit chamber, sludge bed, sludge pumping equipment, and sewer pumping station, at Kenridge Rd.: Contr. B, superstructures. Sanborn & Bogert, 30 Church St., New York, consult. engrs.

Pa., Ambridge—Bids Feb. 17, by Waterworks Comn., Borough Hall, filtration and softening plant, three zeolite softening units, 1 rapid sand filter, coke trays, settling basin and concrete salt brine tank, 1 story storage building over filter and lobby, 2 story building over settling basin, changes in superstructure of existing pumping station, new high and low suction pump included. $100,000. J. N. Chester Engineers, Clark Bldg., Pittsburgh, engrs.

Pa., Phila.—Phila. Electric Co., 9th and Sansome Sts., plan alterations and additions to Richmond Generating Plant, Petty's Island (Delaware River), incl. manufacture and installation of 165,000 kw. electric turbo-generator, foundations, new boilers and equipment, $9,000,000. United Engineers & Constructors, Inc., 112 North Broad St., engrs.

S. C., Abbeville—Abbeville Power Co., c/o J. R. Pennell, 134 Pine St., Spartanburg, plans hydro-electric power plant, Rockey River. $175,000. Mees & Mees, Johnston Bldg., Charlotte, N. C., consult. engrs.

Virginia—Virginia Electric & Power Co., 700 East Franklin St., Richmond, plans extending power lines, power station, improvements and track construction in Richmond, Petersburg, Norfolk, etc. $1,000,000.

Estonia, Riga—Bids Apr. 1, by Municipality of Riga, supply and erection of machinery and works for extending waterworks, incl. boring 9 pipe wells, c.i. pipe, 2 sets centrifugal pumps, direct coupled to 380 volt 50 cycle and being capable of 175 litres per sec. at height of delivery 79.3 metres, transformer station, high tension cables, etc.

Egypt, Cairo—Bids May 10, by Ministry of Public Wks., supplying and erecting Aswan Hydro-Electric Station, incl. building works, turbines, alternators, transformers, switchboards, and all accessories and auxiliary equipment.

Equipment Wanted

PUMPS—**Fabens, Tex.**—Fabens Water Co., J. C. Williams, pres., prepared plans drilling and casing 400 ft. well, installing 2 pumps, 6 in. c.i. mains, erecting 50,000 gal. steel tank on 100 ft. tower, fire hydrants, etc. $15,000 loan has been obtained from Reconstruction Finance Corp. and work is to be advertised shortly. J. S. Barlow, Dallas, engr.

TURBINES and PUMPS—**Fort Wayne, Ind.**—Bids Feb. 14, by City, S. S. Snyder, secy., electric turbines and pumps for new pumping station.

DIESEL ENGINES, etc.—**Waverly, Ia.**—Mar. 1, by City, R. O. Clark, city clk., furnishing, installing 2 diesel engines; one 750 hp. and one 475 hp. direct connected to A.C. generators of 500 kw. and 325 kw. capacity, together with cooling and lubricating systems, exhaust connections and piping; also furnishing current in amount of 500,000 K.W.H. per yr.

PUMPS—**Dunedin, New Zealand**—Bids Mar. 10, by City Clerk, 1 vertical unit centrifugal pump and motor with complete discharging and suction pipes, suction and delivery valves, reflux valve, switch and starting gear, all couplings, and shafts, packing material, bolts, nuts and all accessories.

PUMPS—**Cairo, Egypt**—Bids Mar. 1, by Ministry of Interior, 2 medium pressure centrifugal pumps, each with output of 20 litres per sec. against a manometric height of 48 metres; 2 low pressure pumps (centrifugal) with output 40 litres and 20 litres per sec. respectively, against a manometric height of 12 metres; 1 well pump with output of 30 litres, against height of 58 metres; 1 piston pump, 0.60 metres a minute capacity; 1 hand pump for priming purposes, all complete with piping and all accessories.